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N70-29204

# Research and Technology

# Objective and Plan



# SUMMARY

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## INTRODUCTION

This publication is a summary of the NASA Research and Technology Program for FY 1970. It is a compilation of the "Summary" portions of each of the RTOPs (Research and Technology Objective and Plan) used for management review and control of research currently in progress throughout NASA, except for the Office of Space Science and Applications.\* The RTOP Summary is designed to facilitate communication and coordination among concerned technical personnel in government, in industry, and in universities, and we believe this publication of summary information will be of broad assistance in the technology transfer process.

Cognizant technical monitors are indicated on the RTOP summaries. Although personal exchanges of a professional nature are encouraged, your consideration is requested in avoiding excessive contacts which might be disruptive to on-going research and development.

Any comments or suggestions you may have to help us evaluate or improve the effectiveness of the RTOP Summary would be appreciated. These should be forwarded to:

National Aeronautics and Space Administration  
Office of Advanced Research and Technology  
Program and Resource Division (RMO)  
Washington, D.C. 20546

ORAN W. NICKS  
Acting Associate Administrator for  
Advanced Research and Technology

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\*The NASA OSSA (Office of Space Science and Applications) research and technology activities are not presented here for FY 1970, but will be in the FY 71 edition.

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RTOP NO. 120-05-01 TITLE: NUCLEAR FLIGHT SAFETY RESEARCH AND  
ANALYSIS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RTOP ARE: (1) TO CONDUCT RESEARCH THAT WILL PERMIT ACCURATE AND AUTHORITATIVE PREDICTIONS OF REENTRY CONDITIONS FOR NUCLEAR SPACE POWER SYSTEMS, (2) TO CONDUCT RESEARCH LEADING TO THE ULTIMATE DEVELOPMENT OF NUCLEAR SPACE POWER SYSTEM INTACT REENTRY AND GROUND IMPACT VEHICLES, AND (3) TO PARTICIPATE IN AND PROVIDE SUPPORT FOR THE JOINT DOD/AEC/NASA NUCLEAR FLIGHT SAFETY REVIEW AND EVALUATIONS. TIME-TO-MELT AND HEATING RATE EXPERIMENTS WILL BE PERFORMED ON THERMALLY SCALED MODELS AT APPROPRIATE ARC JET TEST CONDITIONS. CANDIDATE CONFIGURATIONS WILL BE TESTED IN SHOCK TUNNELS AND WIND TUNNELS. RESULTS WILL BE APPLICABLE TO RADIOISOTOPE AND FISSION REACTOR POWER SYSTEMS THAT ARE CANDIDATES FOR MANNED AND UNMANNED SPACE OPERATIONS.

RTOP NO. 120-26-11 TITLE: MERCURY ELECTRON BOMBARDMENT ION THRUSTER  
R/T

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: RICHLEY, E. A. TEL. 216-433-4207

TECHNICAL SUMMARY

THE BROAD OBJECTIVE OF THE WORK DESCRIBED HEREIN IS TO PROVIDE THE BASIC RESEARCH AND TECHNOLOGY PROGRAMS NECESSARY TO ENSURE ORDERLY AND MEANINGFUL ADVANCES IN THE STATE-OF-THE-ART OF ELECTROSTATIC THRUSTERS. THE OVERALL PROGRAM IS DIRECTED AT OBTAINING A MORE THOROUGH UNDERSTANDING OF THE BASIC PHYSICAL PROCESSES OCCURRING IN ELECTROSTATIC THRUSTERS BY CONDUCTING PERTINENT EXPERIMENTAL AND ANALYTIC STUDIES; APPLYING THE KNOWLEDGE GAINED TO THE DESIGN, FABRICATION AND TESTING OF NEW THRUSTER COMPONENTS; INTEGRATION PROMISING NEW COMPONENTS INTO THRUSTERS SIZED FOR WIDEST POSSIBLE APPLICATIONS; EVALUATING THRUSTER PERFORMANCE AND LIFE, AND, FURTHER DEVELOPING PARTICULAR THRUSTERS INTO POTENTIAL FLIGHT-TYPE UNITS. IN ADDITION, STUDIES AND INVESTIGATIONS INTO SYSTEMS INTEGRATION PROBLEMS ARE CONDUCTED TO THE EXTENT NECESSARY TO CLEARLY DEFINE THRUSTER INTERFACE PROBLEM AREAS. SPECIFIC PROGRAMS ARE AIMED AT PROVIDING; LOW VOLTAGE MERCURY BOMBARDMENT THRUSTERS SIZED FOR POSSIBLE APPLICATION FOR PRIMARY ELECTRIC PROPULSION AND FOR ATTITUDE CONTROL AND STATION KEEPING.

RTOP NO. 120-26-12 TITLE: ADVANCED ELECTRIC THRUSTER RESEARCH

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: SEIKEL, G. R. TEL. 216-433-4000

TECHNICAL SUMMARY

OBJECTIVE: TO STUDY ADVANCED ELECTRIC THRUSTERS THAT SHOW PROMISE FOR SPACE MISSIONS. INVESTIGATIONS ARE AIMED AT UNDERSTANDING THE PHYSICS OF THE PROCESSES IN THE THRUSTERS, ACHIEVING EFFICIENT PERFORMANCE, AND DELINEATING MEANS FOR OBTAINING LONG LIFE, LIGHT WEIGHT, AND RELIABLE THRUSTER SYSTEMS. APPROACH:

ANALYTICAL STUDIES AND EXPERIMENTAL STUDIES WHICH INCLUDE EXTENSIVE DIAGNOSTICS AS WELL AS THRUST AND ENERGY EFFICIENCY MEASUREMENTS. LIFETIME AND SYSTEM COMPONENT PROBLEMS WILL ALSO BE INVESTIGATED. ADVANCED ELECTRIC THRUSTERS FOR BOTH HIGH AND LOW POWER WILL BE INVESTIGATED.

RTOP NO. 120-26-13 TITLE: RESISTOJET SYSTEMS TECHNOLOGY FOR MANNED SPACE STATION REACTION CONTROL

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE A BACKGROUND OF INFORMATION FROM WHICH A FLIGHT-QUALIFIED, ELECTRO-THERMAL (RESISTOJET) SYSTEM CAN BE DESIGNED, AND TO CARRY THE RESISTOJET TECHNOLOGY TO THE POINT OF PREQUALIFYING A PROTOTYPE THRUSTER FOR SPACE USE. THE TECHNOLOGY DEVELOPMENT WILL INCLUDE: DESIGNING ELECTRO-THERMAL THRUSTERS FOR USE WITH BIOWASTE AND LIGHT PROPELLANT GASES, VERIFICATION OF POTENTIAL THEORETICAL PERFORMANCE AND STRUCTURAL DESIGN CONSIDERATION TO WITHSTAND LAUNCH AND SPACE CONDITIONS. IN ADDITION, FUTURE PROGRAMS WILL INCLUDE ENVIRONMENTAL AND FUNCTIONAL QUALIFICATION AUXILIARY SYSTEMS SUCH AS VALVES, POWER CONDITIONING EQUIPMENT, ETC. SINCE SIGNIFICANT ADVANTAGES MAY RESULT FROM THE USE OF BIOWASTE GASES AND SINCE THE DESATURATION OF THE CONTROL MOMENT GYROS (CMG) IS ONE OF THE PRIME POTENTIAL USES OF THE RESISTOJET SYSTEM, THE RESISTOJET DEVELOPMENT WILL BE CLOSELY COORDINATED WITH LANGLEY'S EFFORTS IN LIFE SUPPORT AND CMG. THE MAJOR PART OF THIS EFFORT WILL BE ACCOMPLISHED THROUGH A SERIES OF RESEARCH AND DEVELOPMENT CONTRACTS, HOWEVER, SOME IN-HOUSE TESTING IS PLANNED. THE ANTICIPATED RESULT OF THIS PROGRAM IS THE DEMONSTRATION OF A LIGHTWEIGHT, HIGH-PERFORMANCE AND RELIABLE THRUSTER SYSTEM FOR SPACE STATION ORBIT KEEPING AND CMG DESATURATUON.

RTOP NO. 120-26-14 TITLE: ADVANCED PLASMA THRUSTER RESEARCH

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE MPD ARC STANDS OUT AS THE MOST PROMISING ELECTROMAGNETIC TYPE THRUSTER WITH POTENTIAL ADVANTAGES OVER THE ION ENGINE. ALTHOUGH CONTINUING RESEARCH HAS LEAD TO A FAIR UNDERSTANDING OF THE DEVICE, RESEARCH ALONG SEVERAL LINES IS NEEDED IN ORDER TO PROVE ITS POTENTIAL AND TO INCREASE ITS EFFICIENCY. RESEARCH ON THE MPD ARC BY SEVERAL GROUPS INDICATES THAT HIGH EFFICIENCY MAY BE ATTAINABLE FOR CONTINUOUS (STEADY) OPERATION AT HIGH POWERS. IT HAS ALSO BEEN INDICATED THAT THE ADVANTAGES OF HIGH POWER OPERATION COULD BE USED FOR MEDIUM AVERAGE POWER BY REPETITIVE PULSING OF LONG (MILLISECS) PULSES WITH HIGH-POWER QUASI-STEADY OPERATION. RESEARCH WILL BE CARRIED OUT, BOTH IN-HOUSE AND UNDER CONTRACT, TOWARD DESIGN AND DEVELOPMENT OF MPD ARCS FOR CONTINUOUS OPERATION AT HIGH POWERS AND REPETITIVE, LONG (MILLISECS) PULSING FOR MEDIUM AVERAGE POWERS. IN ALL EXPERIMENTS ON THE MAGNETOPLASMA DYNAMIC ARC, EFFECTS OF THE TEST

ENVIRONMENT ON THE PLASMA FLOW ARE PRESENT TO VARYING DEGREES. INDIVIDUAL INVESTIGATORS DEAL WITH THESE EFFECTS IN DIFFERENT WAYS, AS EACH CONCENTRATES IN ONE OR A FEW AREAS OF STUDY. CONTRACT AND IN-HOUSE RESEARCH WILL CONTINUE CONCENTRATED EFFORT TO IDENTIFY THOSE TEST-ENVIRONMENT SOURCES OF PRIMARY INFLUENCE ON THE JET PLUME IN THE TEST TANK AND SEEK TO ELIMINATE AS MANY AS POSSIBLE SO AS TO APPROACH SPACE-LIKE CONDITIONS.-----

RTOP NO. 120-26-16 TITLE: ELECTRIC PROPULSION SYSTEMS TECHNOLOGY  
FOR UNMANNED PLANETARY/INTERPLANETARY  
SPACECRAFT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS ACTIVITY IS THE PREPARATION OF THE TECHNOLOGY OF SOLAR POWERED, ELECTRIC PROPULSION FOR UNMANNED INTERPLANETARY MISSIONS. IT IS BROKEN INTO THREE MAJOR AREAS, MISSION AND TRAJECTORY ANALYSIS, PROPULSION SYSTEM TECHNOLOGY DEVELOPMENT, AND SPACECRAFT/PROPULSION SYSTEM INTERACTIONS. THE OBJECTIVES OF THE MISSION AND TRAJECTORY ANALYSIS EFFORT ARE TO PROVIDE AN EFFICIENT AND VERSATILE TRAJECTORY PERFORMANCE COMPUTATIONAL CAPABILITY AND TO CARRY OUT PARAMETRIC STUDIES OF THE TRAJECTORY-RELATED PROPERTIES OF SPECIFIED ADVANCED PROPULSION MISSIONS. AN INTEGRATED SET OF COMPUTER PROGRAMS FOR SYSTEMS ANALYSIS AND MISSION PERFORMANCE STUDIES OF SOLAR-POWERED ELECTRICALLY PROPELLED SPACE VEHICLES WILL BE DEVELOPED AND EXERCISED. THE LOW-THRUST MISSION ANALYSIS SOFTWARE DEVELOPMENT IS CONTINUING. THE PROGRAMS WILL BE EXERCISED ON SPECIFIC MISSION APPLICATIONS TO PROVE THEIR APPLICABILITY, AND THE DEVELOPED TECHNOLOGIES WILL BE APPLIED TO PRELIMINARY MISSION STUDIES. THE SPECIFIC OBJECTIVE OF THE PROPULSION SYSTEM TECHNOLOGY DEVELOPMENT EFFORT IS THE DEMONSTRATION BY FY 1971 OF A COMPLETE BREADBOARD PROPULSION SYSTEM INCORPORATING ALL FUNCTIONAL AND PERFORMANCE REQUIREMENTS OF A MISSION SPACECRAFT SYSTEM. THIS INCLUDES CLOSED LOOP, VARIABLE POWER THRUSTER OPERATION; CLOSED LOOP THREE AXIS ATTITUDE CONTROL; AND AUTOMATIC FAILURE DETECTION AND CORRECTION.

RTOP NO. 120-26-19 TITLE: INTEGRATED EC/LS-RESISTOJET SYSTEM TECH:  
DEVELOPMENT & DEMONSTRATION

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

STUDIES CONCERNING THE USE OF RESISTOJETS FOR SPACE STATION CMG DESATURATION AND ORBIT KEEPING HAVE SHOWN THAT THIS APPROACH OFFERS CONSIDERABLE PROMISE. THE OPERATION OF THE RESISTOJETS USING GASES RESIDUAL TO THE ENVIRONMENTAL CONTROL/LIFE SUPPORT SYSTEMS COULD RESULT IN CONSIDERABLE SAVINGS IN PROPELLANT RESUPPLY WEIGHT. WHEREAS THE TECHNOLOGY FOR THE DEVELOPMENT OF THE RESISTOJET THRUSTERS IS PROCEEDING WELL UNDER A SEPARATE PROGRAM, ESSENTIALLY NO WORK HAS BEEN DIRECTED TOWARD THE DEVELOPMENT OF THE COMPLETE SYSTEM

REQUIRED TO UTILIZE BIOWASTE GASES. THE OBJECTIVE OF THIS PROGRAM IS TO INCORPORATE THE ONGOING BIOWASTE RESISTOJET TECHNOLOGY INTO AN INTEGRATED ENVIRONMENTAL CONTROL/LIFE SUPPORT-RESISTOJET-CMG SYSTEM DEMONSTRATION PROGRAM. IN THIS PROGRAM RESISTOJETTS WOULD BE OPERATED USING GASES RESIDUAL TO A SABATIER TYPE OXYGEN REGENERATION SYSTEM ON A DUTY CYCLE DICTATED BY CMG DESATURATION AND DRAG MAKEUP REQUIREMENTS FROM A HYPOTHETICAL SPACE STATION IN A PARTICULAR ORBIT AND ORIENTATION. SUBSEQUENTLY, THE MEASURED PERFORMANCE OF THE THRUSTER SYSTEM WOULD BE INTEGRATED INTO THE CMG COMPUTER PROGRAM TO VERIFY THAT DELIVERED PERFORMANCE, RESPONSE, AND SYSTEM RELIABILITY WERE ADEQUATE TO MEET THE DESATURATION AND ORBIT KEEPING REQUIREMENTS. TO ACCOMPLISH THE SYSTEM DEMONSTRATION, THE MAJOR PREPARATORY EFFORT INVOLVES THE SYSTEM TO COLLECT, CONDITION AND FEED THE BIOWASTE GASES TO THE RESISTOJET THRUSTERS. HOWEVER, BEFORE THIS EFFORT CAN BE INITIATED, QUESTIONS REGARDING PROBABLE DUTY CYCLES, DEGREE OF SIMULATION, TYPE OF TEST FACILITY, ETC., MUST BE ANSWERED.

RTOP NO. 120-27-10 TITLE: NUCLEAR BRAYTON POWER SYSTEM  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: PACKE, D. R. TEL. 216-433-6368  
TECHNICAL SUMMARY

THE BRAYTON POWER SYSTEM PROGRAM IS TO PROVIDE HIGHLY RELIABLE, LONG-LIFE SPACE POWER SYSTEMS WITH ELECTRICAL POWER OUTPUT OF A FEW KILOWATTS TO A FEW HUNDRED KILOWATTS DEPENDING ON THE HEAT SOURCE AND MISSION REQUIREMENTS. TYPICAL MISSIONS FOR THESE ENGINES WOULD INCLUDE MANNED SPACE STATIONS, MANNED LUNAR MISSIONS AND UNMANNED MISSIONS REQUIRING POWER LEVELS ABOVE A FEW KILOWATTS. THE BRAYTON ENGINE PROGRAM AT LERC IS A COMBINED IN-HOUSE/CONTRACTOR EFFORT WHERE RESPONSIBILITY FOR THE SYSTEM DESIGN, COMPONENT SPECIFICATIONS, SOME COMPONENT DESIGN, ENGINE ASSEMBLY AND TESTING IS ASSIGNED IN-HOUSE; AND WHERE CONTRACTORS ARE RESPONSIBLE FOR MOST DETAILED COMPONENT DESIGN, FABRICATION AND LIMITED COMPONENTS TESTING. ONE ENGINE, THE B-1, IS IN FULL-SCALE DEVELOPMENT. THIS ENGINE IS DESIGNED TO PRODUCE 2-10 KW OF ELECTRICAL POWER WHEN USED WITH AN ISOTOPE HEAT SOURCE. TWO OTHER ENGINES ARE UNDER STUDY FOR POSSIBLE SUBSEQUENT DEVELOPMENT. THE FIRST IS A MODIFIED B-1 ENGINE FOR USE UP TO A 20 KWE POWER LEVEL; AND THE SECOND IS A NEW 40-160 KWE ENGINE FOR USE WITH A REACTOR HEAT SOURCE.

RTOP NO. 120-27-11 TITLE: BRAYTON ISOTOPE HEAT SOURCE  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: PACKE, D. R. TEL. 216-433-6368  
TECHNICAL SUMMARY

THE BRAYTON ISOTOPE HEAT SOURCE PROGRAM IS TO PROVIDE THE TECHNOLOGY FOR A HIGHLY RELIABLE LONG-LIFE HEAT SOURCE FOR USE WITH THE BRAYTON B-1 ENGINE DESCRIBED IN RTOP 120-67-10. THIS HEAT SOURCE (TOGETHER WITH THE B-1 ENGINE) IS DESIGNED TO MEET POWER REQUIREMENTS IN THE 6 KWE POWER RANGE SUCH AS MANNED SPACE LABORATORIES, INTEGRATED LIFE SUPPORT SYSTEMS, MANNED LUNAR MISSIONS AND UNMANNED MISSIONS. THE ISOTOPE HEAT SOURCE WILL BE DEVELOPED TO GROUND TEST

TECHNOLOGY READINESS. THE ISOTOPE HEAT SOURCE CONSISTS OF: PU-238 CAPSULES (FURNISHED BY THE AEC), A HOT STRUCTURE TO HOLD THE CAPSULES AND A HEAT EXCHANGER TO HEAT BRAYTON CYCLE GAS (BEING DEVELOPED BY LERC), AND A REENTRY AND RECOVERY SUBSYSTEM (AERODYNAMICS TO BE INVESTIGATED BY OTHER NASA CENTERS). THE ISOTOPE HEAT SOURCE WILL BE TESTED AT THE PLUM BROOK SPACE POWER FACILITY WITH THE BRAYTON B-1 ENGINE DESCRIBED IN RTOP 120-17-10.

RTOP NO. 120-27-13 TITLE: ADVANCED NUCLEAR RANKINE POWER SYSTEM  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: PACKE, D. R. TEL.  
TECHNICAL SUMMARY

THE OBJECTIVE OF RTOP IS THE TECHNOLOGY DEVELOPMENT OF A HIGH-TEMPERATURE ALKALI-METAL NUCLEAR RANKINE SPACE ELECTRIC POWER SYSTEM TO BE USED AS AUXILIARY POWER OR FOR ELECTRIC PROPULSION MISSIONS AFTER 1980. TECHNOLOGY WILL BE ESTABLISHED FOR INDIVIDUAL ENGINE COMPONENTS FOLLOWED BY INTEGRATION OF COMPONENTS INTO A PROOF-OF-CONCEPT ENGINE. A NOMINAL 300 KWE POTASSIUM RANKINE SYSTEM HAS BEEN DEFINED AND RELATED SUPPORTING TECHNOLOGY AND INDIVIDUAL COMPONENT DEVELOPMENT IS BEING PURSUED.

RTOP NO. 120-27-14 TITLE: THERMIONIC CONVERSION  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: BREITWIESER, R. TEL. 216-433-6302  
TECHNICAL SUMMARY

REACTOR THERMIONIC SYSTEMS ARE OF INTEREST FOR SPACE POWER GENERATION. THE THERMIONIC REACTOR PROGRAM WILL RECEIVE EMPHASIS IN FY 1970 AND WILL EMPHASIZE OUT-OF-PILE TESTING AIMED AT ESTABLISHING TECHNOLOGY DATA ASSOCIATED WITH: (1) THE FABRICATION VARIABLES, THE DIMENSIONAL STABILITY, THE METALLURGICAL COMPATIBILITY, AND THE ELECTRICAL PERFORMANCE OF FUEL-EMITTER STRUCTURES; (2) UO<sub>2</sub> FISSION GAS VENTS; AND (3) OTHER RESEARCH PROGRAMS INVOLVING INSULATORS AND SEALS, HIGHER PERFORMANCE ELECTRODE MATERIALS, ETC. IN-PILE TESTS WILL BE CONTINUED ON BOTH UO<sub>2</sub> AND THE "NEW" UC-ZRC FUEL IN CAPSULE TESTING AT PLUM BROOK.

RTOP NO. 120-27-15 TITLE: NUCLEAR POWER REACTOR TECHNOLOGY  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: KAUFMAN, S. J. TEL. 216-433-6691  
TECHNICAL SUMMARY

THIS PROGRAM WILL BE TO INVESTIGATE THE KEY TECHNOLOGY NEEDED TO BUILD A COMPACT, FAST REACTOR FOR USE AS THE HEAT SOURCE WHEN COUPLED WITH A DYNAMIC POWER CONVERSION SYSTEM. THE GOAL OF THE PROGRAM IS TO ESTABLISH THE NECESSARY TECHNOLOGY SO THAT A RELIABLE, LONG-LIFE REACTOR CAN BE DEVELOPED FOR SPACE MISSIONS IN THE 1980 TIME PERIOD. THE LONG-RANGE PLANS ARE FOR A REACTOR TO OPERATE WITH COOLANT OUTLET TEMPERATURES ABOVE 2000 DEGREES F AND A NEAR-TERM GOAL (MID-1970'S) OF 1700 DEGREES F AND A 500 KILOWATT ELECTRIC CAPACITY. A REACTOR

CONCEPT HAS BEEN ESTABLISHED, ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS ARE UNDER WAY. THE MAJOR EFFORT AT PRESENT CENTERS AROUND AN IN-PILE FUEL PIN TESTING PROGRAM AND A MATERIALS INVESTIGATION.

RTOP NO. 120-27-16 TITLE: NUCLEAR MERCURY RANKINE POWER SYSTEM  
(SNAP-8)

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: SAARI, M. J. TEL. 216-433-6638

TECHNICAL SUMMARY

THE SNAP-8 PROGRAM IS TO PROVIDE THE TECHNOLOGY FOR A HIGHLY RELIABLE, LONG-LIFE 35-50 KWE SPACE SYSTEM. THE HEAT SOURCE IS TO BE A COMPACT REACTOR WHICH IS UNDER DEVELOPMENT BY THE ATOMIC ENERGY COMMISSION (AEC). THE CONTINUATION DEVELOPMENT PLAN INCLUDES EXTENDED ENDURANCE EVALUATION AND ENVIRONMENTAL TESTING OF COMPONENTS, DEVELOPMENT OF SECONDARY COMPONENTS, DESIGN, FABRICATION AND ASSEMBLY OF A COMPLETE SNAP-8 SYSTEM FOR COMBINED SYSTEM TESTS IN THE PLUM BROOK SPACE POWER FACILITY.

RTOP NO. 120-27-20 TITLE: THERMOELECTRIC SYSTEM TECHNOLOGY

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: EPSTEIN, J. TEL. 201-982-4564

TECHNICAL SUMMARY

THE SUCCESS OF MISSIONS AIMED AT EXPLORING THE OUTER LIMITS OF THE SOLAR SYSTEM WILL DEPEND HEAVILY ON THE AVAILABILITY OF STABLE, LONG TERM RADIOISOTOPE THERMOELECTRIC GENERATORS (RTG). ACCURATE PREDICTIONS FOR LONG TERM PERFORMANCE (>FIVE YEARS) AND THE PRECISE DEFINITIONS OF THE RTG-CREATED ENVIRONMENT ARE REQUIRED. LIFE TEST AND EVALUATION OF SEVERAL RTG CONCEPTS AND SPACECRAFT EXPERIMENTS ARE REQUIRED TO ENHANCE THE SUCCESS PROBABILITY OF THESE MISSIONS. THE PROCESSES INVOLVED IN THE INTERACTIONS WITHIN THE RTG MUST BE DETERMINED AND CONTROLLED. THE DEVELOPMENT OF METHODS FOR MINIMIZING THE ENVIRONMENTAL INTERFERENCE AND THE VERIFICATION OF THESE METHODS BY EMPIRICAL MEANS ARE REQUIRED.

RTOP NO. 120-27-21 TITLE: RTG SPACECRAFT INTEGRATION AND EVALUATION  
FOR PLANETARY & INTERPLANETARY MISSIONS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: FOSTER, J. V. TEL. 415-961-1111

TECHNICAL SUMMARY

AN INVESTIGATION OF THE INFLUENCE OF FLIGHT EXPERIMENT DESIGN FACTORS ON RADIOISOTOPE RADIATION INTERFERENCE IS BEING CONDUCTED SO THAT RADIOISOTOPE POWER SUPPLIES CAN BE ACCOMMODATED ON INTERPLANETARY SPACECRAFT SUCH AS PIONEER/JUPITER, WITHOUT DEGRADING MISSION OBJECTIVES. THE INVESTIGATION COVERS METHODS OF RADIATION INTERFERENCE DISCRIMINATION, ELIMINATION, OR COMPENSATION, (E.G., TRANSDUCER TYPE AND COMBINATION SELECTION, ENERGY DISCRIMINATION, COINCIDENCE REQUIREMENTS, PULSE-SHAPE DISCRIMINATION, PARTIAL SHADOW



SHIELDING, AND ISOTOPE RADIATION SIGNATURE COMPENSATION) .

RTOP NO. 120-27-30 TITLE: NUCLEAR DYNAMIC POWER SYSTEMS INTEGRATION STUDIES

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: RICE, W. E. TEL. 713-483-5273

TECHNICAL SUMMARY

ANALYTICAL NUCLEAR SAFETY STUDIES OF AN ISOTOPE BRAYTON POWER SYSTEM IN A SPACE STATION MISSION WILL BE COMPLETED AND OPERATION OF A BRAYTON CYCLE DEMONSTRATOR WILL BE CONTINUED THROUGH FY 1970.

RTOP NO. 120-27-31 TITLE: NUCLEAR DYNAMIC POWER SYSTEMS INTEGRATION STUDIES

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: RICE, W. E. TEL.

TECHNICAL SUMMARY

AN ANALYTICAL STUDY WILL BE CONDUCTED IN CONJUNCTION WITH OMSF WHICH WILL LEAD TO A PRELIMINARY SAFETY ANALYSIS REVIEW OF THE USE OF A ZR-H REACTOR DYNAMIC POWER SYSTEM IN THE SPACE BASE APPLICATION.

RTOP NO. 120-27-40 TITLE: NUCLEAR REACTOR THERMIONIC SYSTEM TECHNOLOGY

ORGANIZATION: JET PROPULSION LAB

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE OBJECTIVE OF THE NUCLEAR REACTOR THERMIONICS EFFORT IS THE DEVELOPMENT OF MATERIALS, FUEL, COMPONENT, DIODE, REACTOR AND SYSTEM TECHNOLOGY CULMINATING IN THE EVOLUTION OF A TOTAL NUCLEAR THERMIONIC POWER PLANT SYSTEM SUITABLE FOR SPACECRAFT APPLICATIONS FORELECTRIC PROPULSION AND/OR AUXILIARY POWER REQUIREMENTS. THE AEC HAS PRIMARY RESPONSIBILITY FOR THE DEVELOPMENT OF THERMIONIC REACTORS. NASA HAS PRIMARY RESPONSIBILITY FOR THE DEVELOPMENT OF THE ENTIRE NON-NUCLEAR PORTION OF OVERALL POWER PLANTS. THIS INCLUDES HEAT REJECTION SYSTEMS, POWER CONDITIONING, PLANT CONTROLS, SHIELDING AND STRUCTURE.

IN ADDITION, NASA CONTRIBUTES TO CRITICAL REACTOR TECHNOLOGY SUPPORT IN SELECTED KEY AREAS INCLUDING NUCLEAR FUELS, INSULATOR BREAKDOWN, DIODE TECHNOLOGY, REACTOR CONTROL, MATERIALS AND SPECIFIC REACTOR CONCEPTS.-----

RTOP NO. 120-27-41 TITLE: RTG SUPPORT FOR DEEP SPACE ADVANCED SPACECRAFT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THIS TASK PROVIDES THE POWER GENERATOR CONFIGURATION AND INTEGRATION ANALYSIS NECESSARY TO DEFINE THE INTERFACES BETWEEN THE

ELEMENTS OF THE POWER SUBSYSTEM (RTG, BATTERY AND POWER CONDITIONING ELECTRONICS) AND BETWEEN THE POWER SUBSYSTEM AND THE OTHER SPACECRAFT SUBSYSTEMS. IT DEVELOPS THE NECESSARY CAPABILITY, TECHNIQUES AND HARDWARE REQUIRED TO SUCCESSFULLY INTEGRATE AN RTG INTO A SPACECRAFT DESIGN TO EXPLORE THE OUTER PLANETS. OVERALL, THE WORK TO BE DONE INCLUDES: (1) THE DEVELOPMENT OF THE SPECIFICATIONS FOR AN RTG FOR A PROTOTYPE POWER SYSTEM FOR EVALUATION AND TESTING IN TOPS (THERMOELECTRIC OUTER PLANET SPACECRAFT), AN ADVANCED DEVELOPMENT PROJECT THE OBJECTIVE OF WHICH IS TO DEVELOP THE TECHNOLOGY REQUIRED FOR OUTER-PLANET MISSIONS; (2) AN IN-DEPTH NUCLEAR RADIATION PROGRAM TO PROVIDE DATA CONCERNING THE RADIATION SENSITIVITY OF SPACECRAFT SUBSYSTEMS; AND (3) A T/E GENERATOR EVALUATION PROGRAM TO PROVIDE EXPERIMENTAL DATA ON THE PERFORMANCE AND LONG TERM OPERATIONAL CHARACTERISTICS OF RTG UNITS.

RTOP NO. 120-27-42 TITLE: LIQUID METAL MHD RESEARCH  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE CONCEPTUAL FEASIBILITY OF A SPACE ELECTRIC POWERPLANT WITH NO MOVING PARTS THAT COULD OPERATE IN THE PREFERRED SOURCE-TEMPERATURE RANGE OF 1800-2000 DEGREES F WHERE RADIATOR AREA IS SMALL, YET MATERIALS PROBLEMS ARE MINIMAL. A LIQUID METAL MAGNETOHYDRODYNAMIC (MHD) CONVERSION SYSTEM MEETS THE REQUIREMENT OF MOVING MECHANICAL PARTS AND OPERATION AT 1800 - 2000 DEGREES F, AND NO CONVERSION SYSTEM HAS THESE CHARACTERISTICS. THE MHD SYSTEM OPERATES BY ACCELERATING 1800-2000 DEGREES F LITHIUM WITH CESIUM VAPOR AND DECELERATING THE LITHIUM TO PRODUCE ELECTRIC POWER IN A MAGNETOHYDYNAMIC GENERATOR. AN 1800 DEGREES F SYSTEM TEST IS THE PROGRAM GOAL. THE FY '70 OBJECTIVES ARE: (1) CLOSED-LOOP CONVERSION SYSTEM TESTING WITH N2-NAK TO EVALUATE DESIGN APPROACHES FOR THE 1800 DEGREES F SYSTEM, (2) EROSION AND NOZZLE PERFORMANCE MEASUREMENTS WITH 1800-2000 DEGREES F CS-LI, (3) N2-H2O TESTS OF ADVANCED COMPONENT DESIGNS, (4) INSTALLATION OF A 5MW HEAT REJECTION SYSTEM AND SUPPORT EQUIPMENT FOR 1800 DEGREES F SYSTEM TESTING, AND (5) A POWER SYSTEM UTILIZATION STUDY TO PROVIDE SIZE, WEIGHT, AND ELECTRIC-PROPULSION MISSION PERFORMANCE ESTIMATES FOR LIQUID-COMPONENT EFFICIENCIES, CONTAINMENT MATERIAL STRENGTHS, AND LAUNCH CONDITIONS. THE APPLICATION OF THE MHD SYSTEM WOULD BE IN ELECTRIC PROPULSION OR SPACE STATION POWER ABOVE 100 KWE.

RTOP NO. 120-33-10 TITLE: SOLAR CELL POWER TECHNOLOGY AND POWER PROCESSING FOR EARTH ORBITAL SPACE SCIENCE AND APPLICATIONS SATELLITES  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: CHERRY, W. R. TEL. 301-982-5845  
TECHNICAL SUMMARY

MAJOR EMPHASIS OF THE PROGRAM IS TO DEVELOP MORE EFFICIENT, MORE STABLE, LONGER LIFE AND HIGHLY RELIABLE SPACECRAFT SOLAR POWER SYSTEMS FOR EARTH ORBITAL APPLICATIONS. IMPROVEMENTS IN SOLAR CELLS

TO MAKE THEM USEFUL OVER WIDE RANGES OF TEMPERATURE CYCLING, MORE RESISTANT TO ULTRAVIOLET AND ENERGETIC PARTICLE IRRADIATION, AND TO DELIVER MORE WATTS PER POUND OF ARRAY ARE BEING SOUGHT. POWER CONDITIONING DEVELOPMENTS ARE SEEKING TO INCREASES CONVERSION EFFICIENCIES, UTILIZE VERY LOW INPUT VOLTAGES EFFECTIVELY AND TRANSFER POWER FROM A STATIONARY OR ORIENTED PLATFORM, SUCH AS SOLAR ARRAY OR ANTENNA, TO A SPINNING VEHICLE. POWER SYSTEMS STUDIES ARE ENDEAVORING TO DETERMINE THE OPTIMUM OPERATING VOLTAGE RANGES OF A PARTICULAR SPACECRAFT SO AS TO OPTIMIZE THE POWER SUBSYSTEM DESIGN. A SOLAR ARRAY SIMULATOR IS BEING DEVELOPED SO AS TO ENABLE THE EVALUATION OF A SPACECRAFT POWER SYSTEM ON THE GROUND PRIOR TO FLIGHT.

RTOP NO. 120-33-11 TITLE: THIN FILM SOLAR CELL AND HIGH VOLTAGE  
SELF-REGULATING ARRAY TECHNOLOGY

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: BERNATOWICZ, D. T. TEL. 216-433-6786

TECHNICAL SUMMARY

RESEARCH WILL BE CONDUCTED ON THIN FILM SOLAR CELLS WITH EMPHASIS ON OBTAINING AN IMPROVED UNDERSTANDING OF THE PHOTOVOLTAIC EFFECT IN SUCH CELLS AND TOWARD A BETTER UNDERSTANDING OF THE FUNDAMENTAL FACTORS CONTRIBUTING TO PRESENT PERFORMANCE INSTABILITY AND INEFFICIENCY. A LIMITED INVESTIGATION OF STRUCTURAL CONCEPTS FOR PACKAGING AND DEPLOYMENT OF THIN FILM SOLAR CELLS WILL BE CONDUCTED WITH AIM OF IDENTIFYING PERFORMANCE CAPABILITIES OF PROMISING CONCEPTS. WORK WILL BE DONE ON IMPROVED POWER CONDITIONING SYSTEMS (2 LBS/KW) FOR HIGH VOLTAGE SELF-REGULATING SOLAR ARRAYS WITH INTEGRATED SWITCHING AND CONTROL COMPONENTS.

RTOP NO. 120-33-12 TITLE: ADVANCED SOLAR POWER STRUCTURES AND  
RECHARGEABLE BATTERY CELLS FOR MANNED  
SPACE STATIONS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

STRUCTURAL DESIGN REQUIREMENTS FOR SPACE STATION ARRAYS WILL BE DEVELOPED BY CONTRACT FOR ANALYSIS OF INTERACTIONS BETWEEN STATION AND ARRAYS. LIGHT METAL ELECTROFORMING PROCESSES WITH HIGH STRENGTH FIBERS AND ALLOY APPROACHES WILL BE DEVELOPED FOR ARRAY CONSTRUCTION BY CONTRACTS; ARRAYS WILL ALSO BE CONSTRUCTED AND STRUCTURALLY TESTED. THE CHEMICAL POWER OBJECTIVE IS IMPROVEMENT IN PERFORMANCE OF LARGE NICKEL-CADMIUM CELLS. TESTS WILL BE MADE WITH IMPROVED 100-AH CELLS.

RTOP NO. 120-33-13 TITLE: PLANETARY SOLAR ARRAYS AND SOLAR CELL  
TECHNOLOGY

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE WORK PROPOSED UNDER THIS RTOP IS TO DEVELOP THE TECHNOLOGY REQUIRED TO FABRICATE AND EVALUATE SOLAR CELL ARRAYS THAT WILL BE NEEDED FOR FUTURE SPACECRAFT MISSIONS. TASKS TO BE UNDERTAKEN INCLUDE: DEVELOP HIGH POWER (10 KWE) LIGHTWEIGHT (30 W/LB) ROLL-OUT SOLAR ARRAYS FOR MULTI MISSION APPLICATION. WITHOUT THIS LIGHTWEIGHT TECHNOLOGY MANY PROPOSED SPACECRAFT MISSIONS REQUIRING MULTIKILOWATT POWER SOURCES WILL BE IMPOSSIBLE OR SERIOUSLY COMPROMISED BECAUSE OF THE LARGE WEIGHT PENALTIES INVOLVED. DEVELOP TECHNOLOGY FOR A SOLAR ARRAY CAPABLE OF OPERATING ON A MARINER CLASS FLYBY OF THE PLANETS MERCURY AND VENUS. A MERCURY FLYBY SOLAR ARRAY WILL BE EXPOSED TO SOLAR FLUENCES SIX TO TEN TIMES THAT OF EARTH AND TO TEMPERATURES SIGNIFICANTLY ABOVE THE MELTING POINT OF SOLDER. TECHNIQUES WILL BE INVESTIGATED TO OPTIMIZE CELL PERFORMANCE FOR THESE HIGH INTENSITIES, IMPROVE PANEL FABRICATION AND MATERIALS, AND PROVIDE ADEQUATE THERMAL CONTROL. DEVELOP A LIGHTWEIGHT SOLAR PANEL DESIGN USING THE NASA 20 WATT/LB TECHNOLOGY FOR POSSIBLE APPLICATION OF MARINER/VIKING CLASS SPACECRAFT. COMPARED WITH PRESENT TECHNOLOGY A ONE-KW SOLAR ARRAY'S WEIGHT COULD BE REDUCED 50 POUNDS WITH 20 WATT/LB TECHNOLOGY. DEVELOP IMPROVED, LOW-COST SOLAR CELL CONTACT AND INTERCONNECTS TO IMPROVE SOLAR CELL PERFORMANCE AND REDUCE THE COST OF ARRAY FABRICATION, FOR EXAMPLE THROUGH DEVELOPMENT OF TECHNIQUES WHICH MORE INTIMATELY INTEGRATE THE CELL INTO THE SOLAR PANEL. DEVELOP, TEST, AND EVALUATE CONVENTIONAL AND ADVANCED CONCEPT SOLAR CELLS AND SOLAR PANEL ASSEMBLIES FOR APPLICATION TO SPACECRAFT MISSIONS. THIS EFFORT IS NECESSARY TO PROVIDE DESIGN INFORMATION FOR THE DEVELOPMENT OF FUTURE SOLAR ARRAY HARDWARE. CONTINUE THE STANDARDIZATION OF SOLAR CELLS USING THE JPL HIGH-ALTITUDE BALLOON CALIBRATION TECHNIQUE. DEVELOP SOLAR ARRAY TECHNOLOGY REQUIRED TO DESIGN A POWER SOURCE FOR MARS' SURFACE APPLICATION. THIS TECHNOLOGY WILL BE INVESTIGATED THROUGH ANALYTICAL AND EMPIRICAL STUDY OF CELLS IN A MARTIAN ENVIRONMENT.

RTOP NO. 120-33-14 TITLE: SPACE RADIATION DAMAGE TO SOLAR CELLS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE EFFECTS OF RADIATION DAMAGE AND TECHNIQUES TO RADIATION HARDEN SOLAR CELLS WILL CONTINUE TO BE INVESTIGATED. PROGRAMS WILL INCLUDE: DETERMINATION OF THE EFFECTS OF LITHIUM AND OTHER DOPANTS ON IMPROVING SOLAR CELL RADIATION RESISTANCE, THE DEVELOPMENT OF A REVISED VERSION OF THE NASA HANDBOOK OF SPACE ENVIRONMENTAL EFFECTS ON SOLAR CELL POWER SYSTEMS, THE EVALUATION OF THE ATS-E SOLAR CELL FLIGHT EXPERIMENT DATA AND THE DEVELOPMENT OF ENGINEERING INFORMATION ON THE DEGRADATION OF CELLS UNDER PARTICLE IRRADIATION AT EXTREME TEMPERATURES AND INCIDENCE ANGLES.

RTOP NO. 120-33-15 TITLE: EFFECT OF JOVIAN ENVIRONMENT ON SOLAR CELLS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: FOSTER, J. V. TEL. 415-961-1111

TECHNICAL SUMMARY

STUDIES OF THE SILICON H/P SOLAR CELL OPERATING CHARACTERISTICS AND THE INFLUENCE OF THE SPACE RADIATION ENVIRONMENT ON THEIR PERFORMANCE ARE BEING PERFORMED FOR INTERPLANETARY MISSIONS. PREVIOUS STUDIES CONCENTRATED ON ELEVATED TEMPERATURES AND HIGH INTENSITIES; PRESENT WORK EMPHASIZES LOW TEMPERATURES AND LOW INTENSITIES ENCOUNTERED ON A JUPITER TYPE MISSION. A COMPREHENSIVE COMPUTER PROGRAM, VERSATILE SOLAR SIMULATORS, TEMPERATURE CONTROLLED VACUUM IRRADIATION FACILITIES AND INSTRUMENTATION FOR COMPLETE ELECTRICAL AND OPTICAL CHARACTERIZATION OF PROPERTIES AND ELECTRICAL PERFORMANCE HAS BEEN ASSEMBLED. CONTACT HAS BEEN ESTABLISHED WITH EXPERTS AT OTHER NASA CENTERS TO HELP DETERMINE CELL AND COVERGLASS PARAMETERS AND TO DERIVE ANALYTICAL RELATIONSHIPS REQUIRED FOR THE DEVELOPMENT AND EVALUATION OF PHOTOVOLTAIC SYSTEMS FOR INTERPLANETARY MISSIONS.

RTOP NO. 120-33-16 TITLE: SOLAR POWER SYSTEM TECHNOLOGY FOR LARGE ORBITING VEHICLES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO ACHIEVE TECHNOLOGY READINESS OF LARGE SOLAR POWER SYSTEMS FOR EARTH ORBITAL APPLICATIONS IN THE POST-1974 TIME PERIOD. FOR THIS PERIOD, THE TECHNOLOGY GOALS ARE: (1) SYSTEM SPECIFIC WEIGHT OF 500 LBS/KILOWATT, (2) TEN-YEAR LIFE WITH MAINTENANCE, AND (3) AN EFFICIENCY RESULTING IN A FIGURE-OF-MERIT OF 200 SQUARE FEET OF ARRAY PER KILOWATT OF AVERAGE REGULATED LOAD POWER. ELEMENTS OF TECHNOLOGY MAY BE SPECIFIC ARTICLES OF HARDWARE, ANALYTICAL TECHNIQUES, OR PROCESSES. LACKING THE DEFINITION OF A REAL MISSION AND A REAL SPACECRAFT FOR THIS TIME FRAME, A BRIEF SURVEY OF THE POTENTIAL MISSIONS AND THE POTENTIAL SPACECRAFT WILL BE EXAMINED IN ORDER TO DETERMINE REASONABLE SPACECRAFT-POWER-SYSTEM REQUIREMENTS AND CONFIGURATIONS. THIS REVIEW WILL ALSO PROVIDE A REASONABLE MEASURE OF THE ENVIRONMENTAL REQUIREMENTS AND AID IN THE ESTABLISHMENT OF REASONABLE PERFORMANCE CRITERIA. FROM THIS REVIEW THE HARDWARE AND ANALYTICAL TECHNIQUES IN WHICH WE LACK CONFIDENCE CAN BE SINGLED OUT AND DEVELOPED FOR A TYPICAL APPLICATION. THE PROGRAM COVERED BY THIS RTOP WAS TRANSFERRED TO MSC IN OCTOBER 1969. JPL WAS DIRECTED TO EFFECT AN ORDERLY CLOSE OUT OF ALL IN-HOUSE WORK UNDER THIS RTOP AND COMPLETE ALL NECESSARY TECHNICAL REPORTS BY JUNE 30, 1970. PROPOSED CONTRACTS WITH THE BOEING COMPANY AND THE GENERAL ELECTRIC COMPANY WERE CANCELLED PRIOR TO INITIATION OF FORMAL NEGOTIATIONS.

RTOP NO. 120-33-18 TITLE: MULTIKILOWATT SOLAR ARRAY/BATTERY POWER  
GENERATION SYSTEMS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: BRIGLIO, A., JR. TEL.

TECHNICAL SUMMARY

ANALYTICAL AND EXPERIMENTAL WORK WILL BE UNDERTAKEN TO ACHIEVE TECHNOLOGY READINESS OF MULTIKILOWATT SOLAR ARRAY/RECHARGEABLE BATTERY POWER GENERATION SYSTEMS FOR A SPACE STATION TO BE LAUNCHED IN THE LATTER PART OF THE DECADE (I.E., 1977 OR LATER). NEAR TERM GOALS ARE 1,000 LB/KW TO BE ACHIEVED BY 1974. NEAR TERM GOAL FOR BATTERY CYCLE LIFE IS TWO YEARS WITH A 1974 GOAL OF FIVE YEARS.

RTOP NO. 120-34-10 TITLE: PLANETARY BATTERIES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE PURPOSE OF THIS TASK IS TO DEVELOP THE BATTERY TECHNOLOGY FOR PLANETARY MISSIONS. INFORMATION WILL BE OBTAINED ON BATTERY DESIGN, PERFORMANCE AND CONTROL TECHNIQUES WHICH WILL PROVIDE THE BASIS FOR OPTIMIZING BATTERY POWER SYSTEMS IN PLANETARY FLY-BY, ORBITING AND LANDED MISSIONS. INVESTIGATIONS WILL BE CONDUCTED INTO THE ELECTROCHEMICAL AREAS OF REACTION MECHANISMS, ELECTRODE BEHAVIOR, AND ENVIRONMENTAL EFFECTS (SUCH AS RADIATION, THERMAL-VACUUM, AND GRAVITY) AS WELL AS INTO THE AREAS OF PERFORMANCE VARIATIONS DUE TO MATERIALS, COMPONENTS, CELL AND BATTERY CONFIGURATIONS, AND ELECTRICAL CONDITIONING. TESTING OF COMPONENTS, CELLS, BATTERIES, AND BATTERY SYSTEMS WILL BE DONE TO SIMULATE FUTURE POWER REQUIREMENTS ON A REAL TIME BASIS WHENEVER POSSIBLE. THE SPECIFIC HARDWARE AND INFORMATION SOUGHT FROM THIS TASK ARE: 1) BATTERIES CAPABLE OF VARIABLE DUTY CYCLE COUPLED WITH LONG LIFE, 2) LONG LIFE BATTERIES AND BATTERY SYSTEMS (10 YEARS AND MORE), 3) STERILIZABLE AND IMPACT RESISTANT BATTERIES, AND 4) DEVICES AND TECHNIQUES FOR ON BOARD ANALYSIS OF BATTERY CONDITIONS AND CORRECTION CAPABILITY OF MALFUNCTIONS. THE ELECTROCHEMICAL SYSTEMS TO BE INVESTIGATED INCLUDE THE ALKALINE SILVER-ZINC, NICKEL-CADMIUM, RESERVE BATTERY SYSTEMS, AND PRIMARY AND SECONDARY SYSTEMS.

RTOP NO. 120-34-11 TITLE: SATELLITE BATTERIES

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: HENNIGAN, T. J. TEL. 301-982-5547

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP RECHARGEABLE SATELLITE BATTERIES CAPABLE OF TEN YEARS RELIABLE OPERATING LIFE IN EARTH ORBIT. MAJOR PROBLEMS INCLUDE: (A) SEPARATOR DEGRADATION; (B) PLATE INSTABILITY; (C) INTERNAL GASSING; (D) HERMETIC SEALS; (E) THERMAL CONTROL; AND (F) INADEQUATE CONTROL OF MATERIALS AND CELL PROCESSING.

A MAJOR CONTINUING ACTIVITY IS THE BATTERY TEST PROGRAM CONDUCTED FOR GSFC BY THE NAVAL AMMUNITION DEPOT, CRANE, INDIANA.

RTOP NO. 120-34-12 TITLE: ELECTROCHEMICAL POWER DEVICES  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: SCHWARTZ, H. J. TEL. 216-433-4000  
TECHNICAL SUMMARY

RESEARCH WILL BE CONDUCTED ON INORGANIC SEPARATOR ALKALINE BATTERY TECHNOLOGY, ON HIGH ENERGY DENSITY METAL-OXYGEN SYSTEMS AND ON SOLID IONIC CONDUCTORS. THE BATTERY TECHNOLOGY WORK SEEKS IMPROVEMENTS IN INORGANIC SEPARATOR BATTERIES FOR USE IN RELATIVELY EXTREME ENVIRONMENTS. RESEARCH IS BEING PERFORMED ON HIGH ENERGY METAL-OXYGEN ELECTROCHEMICAL SYSTEMS AND SOLID IONIC CONDUCTORS. SOME FUEL CELL WORK IS DIRECTED TOWARD IMPROVEMENT OF THE LOW TEMPERATURE, ALKALINE, MATRIX TYPE HYDROGEN-OXYGEN CELL.

RTOP NO. 120-34-13 TITLE: POWER SOURCES AND CONVERSION  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: WARSCHAUER, D. M. TEL. 617-494-2510  
TECHNICAL SUMMARY

THIS WORK STRESSES DEVELOPMENT OF NEW CONCEPTS AND NEW MATERIALS, AND RESEARCH ON EXISTING COMPONENTS TO IMPROVE THE AVAILABILITY OF EFFICIENT, RELIABLE, AND LONG LIVED PRIMARY AND SECONDARY SOURCES AND CONVERSION DEVICES. INVOLVED ARE STUDIES OF MECHANISMS, MATERIALS AND COMPONENTS RELATING TO UNIQUE FUEL CELL, BATTERY AND SOLAR CELL CONCEPTS.

RTOP NO. 120-34-14 TITLE: SOLAR AND CHEMICAL POWER SYSTEMS FOR  
LUNAR EXPLORATION  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: WARSCHAUER, D. M. TEL. 205-453-1120  
TECHNICAL SUMMARY

THIS RTOP SETS FORTH A SERIES OF CAREFULLY PLANNED STUDY EFFORTS WHICH PROVIDE AN INTEGRATED PROGRAM OF ACTIVITIES LEADING TOWARD THE SUCCESSFUL DEVELOPMENT OF SELECTED POWER SYSTEMS AND COMPONENTS ENCOMPASSING THE AREAS OF SOLAR AND CHEMICAL POWER GENERATION. THIS WORK IS ATTEMPTING TO SOLVE THE SYSTEM AND INTERFACES PROBLEMS OF SOLAR AND CHEMICAL POWER SUPPLIES FOR OPERATION ON THE LUNAR SURFACE INCLUDING POWER FOR A SHELTER BASE, PERSONNEL BACKPACKS, COMMUNICATIONS, VEHICLES, TOOLS, AND EXPERIMENT PACKAGES. OBJECTIVES WILL BE ACCOMPLISHED BY INHOUSE STUDIES AND SEVERAL CONTRACT STUDIES AND RELATED ANALYSIS WITH MSFC COORDINATION AND REQUIREMENTS INPUT. INHOUSE EFFORTS COORDINATED BETWEEN VARIOUS LABORATORIES AND THE PROGRAM DEVELOPMENT ORGANIZATION OF MSFC WILL BE MISSION ORIENTED TO DETERMINE INTERFACES REQUIREMENTS FOR THE VARIOUS SYSTEMS.



RTOP NO. 120-34-19 TITLE: FUEL CELL SYSTEMS TECHNOLOGY FOR SPACE SHUTTLE

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: RICE, W. E. TEL.

TECHNICAL SUMMARY

A SINGLE CONTRACT, WILL BE AWARDED IN LATE FY 70 TOWARD TECHNOLOGY READINESS OF A MARK I LEVEL FUEL CELL FOR A FUTURE SPACE SHUTTLE.

RTOP NO. 120-34-21 TITLE: AUXILIARY POWER UNIT FOR SPACE SHUTTLE

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: SCHWARTZ, H. J. TEL. 216-433-6910

TECHNICAL SUMMARY

SUBSTANTIAL HYDRAULIC AND/OR MIXED HYDRAULIC AND ELECTRICAL LOADS MUST BE MET BY THE POWER SUBSYSTEMS DURING THE MISSION PERIOD BETWEEN BOOSTER ENGINE CUTOFF AFTER LAUNCH AND STARTING OF THE TURBOJET ENGINES AFTER REENTRY OF THE BOOSTER AND ORBITER VEHICLES. AN AUXILIARY POWER UNIT CONSISTING OF A TURBINE DRIVE SYSTEM COUPLED WITH A HYDRAULIC PUMP, AND POSSIBLY AN ALTERNATOR, WILL BE REQUIRED FOR THE MOVEMENT OF AERODYNAMIC CONTROL SURFACES, DEPLOYMENT OF JET ENGINES OR OPENING OF INLETS AND EXITS FOR INTERNALLY MOUNTED ENGINES, AND TO MEET PEAK ELECTRICAL LOADS ASSOCIATED WITH REENTRY AND TRANSITION OF THE VEHICLE TO AN AIRCRAFT OPERATING MODE. WORK WILL BE DIRECTED TOWARD DEFINITION OF APU DUTY REQUIREMENTS, SELECTION OF DESIGN CONCEPTS INCLUDING CHOICE OF FUEL AND OXIDIZER, COMPONENT DESIGN AND TESTING, PROTOTYPE DESIGN AND FABRICATION AND ENDURANCE TESTING TO DEMONSTRATE TECHNOLOGY READINESS.

RTOP NO. 120-60-01 TITLE: POWER PROCESSING RESEARCH AND ADVANCED DEVELOPMENT FOR ELECTRIC PROPULSION SYSTEMS

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: SCHWARZ, F. C. TEL. 617-494-2006

TECHNICAL SUMMARY

OBJECTIVES: ESTABLISH TECHNOLOGY FOR SINGLE-MODULE MULTIKILOWATT ELECTRIC POWER DC CONVERTERS WHICH CAN BE CLUSTERED TO ATTAIN POWER LEVELS OF TENS AND HUNDREDS OF KILOWATTS; TO PROVIDE THESE CONVERTERS WITH THE NEEDED MEANS OF CONTROL INCLUDING MAXIMUM POWER TRACKING AND ACCURACY OF DESIGN PERFORMANCE; TO MAXIMIZE RELIABILITY AND EFFICIENCY OF OPERATION AND TO MINIMIZE PHYSICAL WEIGHT AND SIZE. APPLICATIONS: SOLAR AND NUCLEAR-POWERED ELECTRIC PROPULSION SYSTEMS; TO BE CLOSELY COORDINATED WITH JPL'S EFFORT IN THIS FIELD. APPROACH: RELIABILITY ADVANCEMENT WILL BE ACHIEVED THROUGH DEVELOPMENT OF CIRCUITS AND FUNCTIONAL CONCEPTS WHICH MINIMIZE STRESSES ON INDIVIDUAL COMPONENTS. WEIGHT REDUCTIONS WILL BE ACHIEVED BY PROVIDING CAPABILITY FOR OPERATING AT HIGHER INPUT VOLTAGE LEVELS AND AT SUBSTANTIALLY HIGHER SWITCHING FREQUENCIES THAN PRESENTLY POSSIBLE.



RTOP NO. 120-60-02 TITLE: AIRCRAFT ELECTRICAL POWER SYSTEM  
TECHNOLOGY

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: SCHWARZ, F. C. TEL. 617-494-2006

TECHNICAL SUMMARY

OBJECTIVES: ESTABLISH IMPROVED AIRCRAFT ELECTRIC SYSTEMS TECHNOLOGY (1) WITH A SUBSTANTIAL INCREASE IN RELIABILITY FOR REDUCED MAINTENANCE OF FLIGHT AND SUPPORTING GROUND BASED EQUIPMENT, (2) WITH A SIGNIFICANT IMPROVEMENT OF THE KW/KG RATIO OF THE OVER ALL ELECTRIC SYSTEM FOR INCREASED PHYSICAL WEIGHT OF PAYLOAD VS FLIGHT EQUIPMENT IN AIRCRAFT. APPLICATIONS: ALL AIRCRAFT. APPROACH: GENERATION OF AN AIRCRAFT ELECTRIC SYSTEMS TECHNOLOGY BASED ON THE SIMULTANEOUS OPTIMIZATION OF SYSTEM COMPONENTS TO MEET THE OBJECTIVES. THE MAJOR SPECIFIC EFFORT IN FY 70 WILL BE THE COMPLETION OF A SURVEY OF EXISTING AIRCRAFT ELECTRICAL SYSTEMS TECHNOLOGY WITH A VIEW OF HIGHLIGHTING SIGNIFICANT AREAS WHERE TECHNOLOGICAL ADVANCES WILL BE OF SUBSTANTIAL BENEFIT. PREPARATION OF A FINAL STUDY REPORT WILL BE THE MAJOR FY 70 OBJECTIVE.

RTOP NO. 120-60-03 TITLE: SPACECRAFT ELECTRICAL POWER PROCESSING  
AND DISTRIBUTION

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: SCHWARZ, F. C. TEL. 617-494-2006

TECHNICAL SUMMARY

OBJECTIVES: ESTABLISH AN IMPROVED UNDERSTANDING OF THE BASIC THEORY AND PHYSICAL PHENOMENA, PARTICULARLY UNDER DYNAMIC CONDITIONS, OF POWER PROCESSING CIRCUITS AND COMPONENTS, TOGETHER WITH ADVANCED METHODS OF ANALYSIS AND RELATED DESIGN METHODOLOGY. GENERAL ADVANCEMENT IN CIRCUITS, COMPONENTS AND MATERIALS NEEDED FOR NEXT GENERATION CONCEPTS IN ELECTRICAL POWER ELECTRONICS. APPLICATIONS: FLIGHT MISSIONS WITH DURATION OF TEN YEARS; ACTIVE SPACECRAFT AND SATELLITES FOR SURVEY, SCIENTIFIC OR COMMUNICATION PURPOSES. APPROACH: ACQUIRE KNOWLEDGE OF THE NATURE OF ELECTRIC SPACE POWER SYSTEMS, THEIR SUBSYSTEM AND COMPONENT PARTS. UTILIZE THIS KNOWLEDGE FOR TECHNOLOGY IMPROVEMENT.

RTOP NO. 120-60-04 TITLE: POWER PROCESSING AND DISTRIBUTION FOR  
PLANETARY SPACECRAFT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THIS TASK PROVIDES FOR THE DEVELOPMENT OF ELECTRICAL POWER PROCESSING, DISTRIBUTION, AND RELATED POWER SYSTEM CONFIGURATION AND INTEGRATION TECHNOLOGY FOR FUTURE PLANETARY SPACECRAFT. IT DEVELOPS THE NECESSARY CAPABILITY, TECHNIQUES, AND HARDWARE REQUIRED TO PRODUCE HIGH-RELIABILITY POWER SYSTEMS FOR ADVANCED "MARINER-TYPE" AND OUTER-PLANET MISSIONS. THE PRESENT POWER PROCESSING AND DISTRIBUTION TECHNOLOGY IS GROSSLY INADEQUATE FOR FUTURE MISSIONS SUCH AS THE GRAND TOUR WHICH REQUIRES UP TO 12 YEARS LIFE, A WEIGHT OF 50 LBS/KW OR LESS, AND IMMUNITY FROM SINGLE PIECE-PART FAILURE.

THE WORK TO BE DONE INCLUDES: (1) THE DEVELOPMENT OF A BREADBOARD POWER PROCESSING AND DISTRIBUTION SYSTEM FOR EVALUATION AND TESTING IN THE THERMOELECTRIC OUTER PLANET SPACECRAFT (TOPS) PROJECT, ENCOMPASSING ALSO THE SYSTEM ANALYSIS AND INTEGRATION EFFORTS NECESSARY TO OPTIMIZE THE POWER PROCESSING SYSTEM CONFIGURATION WITH RESPECT TO THE RTG SOURCE CHARACTERISTICS AND THE USER LOAD REQUIREMENTS, AND (2) THE DEVELOPMENT OF NEW TECHNOLOGY PROTOTYPE OR BREADBOARD POWER PROCESSING ELEMENTS FOR ADVANCED "MARINER-TYPE" SPACECRAFT. THE PURPOSE OF THIS WORK IS TO DEMONSTRATE THE APPLICABILITY OF NEW TECHNOLOGY EMERGING FROM INDUSTRY AND NASA CENTERS (SUCH AS ERC) TO FUTURE MISSIONS. THE WORK WILL BE CARRIED ONLY FAR ENOUGH TO PROVIDE ADEQUATE JUSTIFICATION TO FUTURE PROJECTS THAT THE TECHNOLOGY IS "FLIGHT READY" AND IS CAPABLE OF BEING ADAPTED TO TYPICAL "MARINER-TYPE" PLANETARY SPACECRAFT REQUIREMENTS.

RTOP No. 120-60-10 TITLE: SPACE SHUTTLE ELECTRICAL POWER PROCESSING AND DISTRIBUTION TECHNOLOGY

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: SCHWARZ, F. C. TEL. 617-494-2006

TECHNICAL SUMMARY

OBJECTIVES: ESTABLISH TECHNICAL CRITERIA FOR CONCURRENT OPTIMIZATION OF ELECTRIC POWER SOURCES, DISTRIBUTION, CONVERSION AND UTILIZATION TECHNOLOGY FOR DESIGN OF POWER SYSTEMS AND THEIR SUBSYSTEMS OF REUSEABLE LARGER HYBRID AIR AND SPACEBORNE CRAFT, REQUIRING POWER CAPACITIES IN THE ORDER OF TENS OF KW IN SPACE AND HUNDREDS OF KVA WHEN AIRBORNE, AND WITH DUE CONSIDERATION OF THE POWER SYSTEMS TRANSITION PHASE DURING REENTRY INTO THE ATMOSPHERE. APPLICATIONS: REUSEABLE SPACE SHUTTLE LAUNCH AND ORBITER CRAFT; ALSO APPLICABLE TO OTHER AIR AND LARGER SPACECRAFT. APPROACH: ACQUIRE KNOWLEDGE ON THE NATURE OF POWER SYSTEM CHARACTERISTICS AND THE ASSOCIATED SUBSYSTEMS UNDER GIVEN CONSTRAINTS AND TRANSLATE THE RESULTS OF COMPARATIVE WEIGHTING OF CONTRIBUTING FACTORS INTO CRITERIA FOR DESIGN. ESTABLISH TECHNOLOGY FOR CRITICAL SUBSYSTEMS AND COMPONENTS, SUCH AS CONVERTER TECHNOLOGY, EQUIPMENT FOR POWER TRANSFER AND TRANSMISSION, ELECTRIC ENERGY MANAGEMENT POWER FAULT DETECTION, AND THEIR COMPONENT PARTS. THE MAJOR FY 70 OBJECTIVE IS THE INITIATION OF A POWER DISTRIBUTION SYSTEM STUDY (JOINT EFFORT WITH SPACE STATION RTOP 120-67-20) BY JUNE 1970. WITH THE CLOSURE OF ERC, STEPS ARE BEING TAKEN TO INITIATE SUCH A STUDY FROM LERC BY JUNE 1970 OR EARLY 1971. THE PROPOSE OF THE STUDY IS CONSIDERED URGENT AND ESSENTIAL AS THE FIRST STEP TOWARD DEFINING DETAIL TECHNOLOGY FOR THE SHUTTLE AND SPACE STATION.

RTOP No. 120-60-20 TITLE: SPACE STATION/BASE ELECTRICAL POWER PROCESSING AND DISTRIBUTION

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: SCHWARZ, F. C. TEL. 617-494-2006

TECHNICAL SUMMARY

OBJECTIVE: ESTABLISH THE NEEDED TECHNOLOGY FOR THE POWER PROCESSING AND DISTRIBUTION SYSTEM FOR THE SPACE STATION/BASE.

ESTABLISH TECHNICAL CRITERIA FOR CONCURRENT OPTIMIZATION OF ELECTRIC POWER SOURCES INTERFACE WITH THE ELECTRIC DISTRIBUTION SYSTEM, IDENTIFY THE REQUIRED TYPE OF ELECTRIC POWER DISTRIBUTION. ESTABLISH THE TECHNOLOGY FOR NEEDED POWER ELECTRONIC COMPONENTS SUCH AS SOLID STATE SWITCH GEAR, INVERTERS, CONVERTERS FOR THE TRANSFER AND TRANSFORMATION OF ELECTRIC POWER ON THE MULTIKILOWATT LEVEL, COMPATIBLE WITH 30-200 KW POWER SYSTEMS. APPLICATIONS: LARGE SPACECRAFT, SUCH AS SPACE STATION AND A SPACE BASE. APPROACH: ACQUIRE KNOWLEDGE ON THE NATURE OF POWER SYSTEMS CHARACTERISTICS AND THE ASSOCIATED SUBSYSTEMS UNDER GIVEN CONSTRAINTS AND TRANSLATE THE RESULTS OF A COMPARATIVE STUDY OF CONTRIBUTING FACTORS INTO CRITERIA FOR DESIGN. WITH THE CLOSURE OF ERC, LITTLE PROGRESS WILL BE MADE IN FY 70 UNDER THIS RTOP EXCEPT AN ATTEMPT TO INITIATE A POWER DISTRIBUTION SYSTEM STUDY BY JUNE 1970 OR IN EARLY FY 71 (JOINT EFFORT WITH SHUTTLE RTOP 120-64-10) FROM LERC. THE STUDY IS A NEEDED FIRST STEP TOWARD FORMULATION OF SPECIFIC WORK EFFORTS AND TECHNOLOGY MILESTONES.

RTOP NO. 121-30-10 TITLE: NUCLEAR VEHICLE-SPACECRAFT SHIELDING  
DESIGN ANALYSIS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: SCHWARZ, F. C. TEL. 205-453-1120

#### TECHNICAL SUMMARY

THE OBJECTIVES OF THE PROGRAM ARE TO FURTHER DEVELOP AND MAINTAIN A SHIELDING DESIGN AND ANALYSIS CAPABILITY AND TO UTILIZE THIS CAPABILITY IN INDEPENDENTLY-CONDUCTED SHIELDING STUDIES FOR APPLICATION TO NUCLEAR ROCKET STAGE DEVELOPMENT. THE CONCEPT OF NUCLEAR PROPULSION HAS BEEN THOROUGHLY STUDIED, AND THE FEASIBILITY OF WORKABLE SPACE PROPULSION SYSTEMS WELL DEMONSTRATED. MANY PROBLEMS STILL EXIST, HOWEVER, AMONG THE MORE SIGNIFICANT OF WHICH IS THE ADEQUATE ASSESSMENT OF AND PROVISION FOR THE RADIATION ENVIRONMENT. IN ORDER TO PROTECT ADEQUATELY ALL COMPONENTS, SYSTEMS, AND PERSONNEL AGAINST THE DELETERIOUS EFFECTS OF NUCLEAR RADIATION, IT IS NECESSARY TO UTILIZE COMPLEX RADIATION TRANSPORT PROCEDURES TO DETERMINE DOSE RATES AT VARIOUS LOCATIONS AROUND THE REACTOR SHIELD ASSEMBLY AND TO DESIGN SHIELD TO REDUCE ANY EXCESSIVE DOSE RATES TO ACCEPTABLE LEVELS. TO OBTAIN THOSE GOALS, A PROGRAM OF CONTINUING CODE DEVELOPMENT AND REFINEMENT IS OUTLINED, ALONG WITH A SUSTAINED EFFORT TO COLLECT, UPDATE, EVALUATE, AND PREPARE INPUT DATA FOR USE IN THE AVAILABLE CODES. THE CALCULATION METHODS WILL BE USED TO OBTAIN OPERATIONAL DOSE RATES, ACTIVATION LEVELS, AND AFTER-SHUTDOWN RADIATION FIELDS FOR TYPICAL NUCLEAR ROCKET CONFIGURATIONS AND TO AID IN SHIELD DESIGN OPTIMIZATION STUDIES.

RTOP NO. 121-30-11 TITLE: RADIATION RESISTANT STAGE EQUIPMENT AND MATERIALS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: SCHWARZ, F. C. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVES ARE THE EVALUATION OF; (1) EXISTING SATURN STAGE TECHNOLOGY, SYSTEMS, AND MATERIALS, AND (2) NEWLY DEVELOPED SYSTEMS, SUBSYSTEMS, COMPONENTS AND SELECTED MATERIALS TO DETERMINE THEIR ADEQUACY FOR MEETING REQUIREMENTS OF NUCLEAR STAGE OPERATION THROUGH ENGINEERING ANALYSIS AND APPLICATION OF APPROPRIATE RADIATION CRITERIA. THIS TECHNOLOGY IS APPLICABLE TO THE DEVELOPMENT OF NUCLEAR STAGES WHICH MAY BE THE OUTGROWTH OF NUCLEAR FLIGHT PROPULSION MODULE DEFINITION WORK CURRENTLY BEING UNDERTAKEN. THE EVALUATION WOULD CONSIST OF EXPOSING DEVICES SYSTEMS, SUB-SYSTEMS, COMPONENTS, STRUCTURES, AND MATERIALS TO A RADIATION ENVIRONMENT WITH MONITORING AND TESTING TO DETERMINE COMPATIBILITY. A COMPLEMENTARY SYSTEMS ENGINEERING EFFORT WILL AID THE SELECTION OF SYSTEMS AND SUB-SYSTEMS MOST APPLICABLE TO A FUTURE NUCLEAR STAGE.

RTOP NO. 121-30-12 TITLE: NUCLEAR PROPELLANT HEATING AND STRATIFICATION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: SCHWARZ, F. C. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVES ARE TO DEFINE THE NUCLEAR AND THERMODYNAMIC INTERACTIONS RESULTING FROM THE DEPOSITION OF NUCLEAR ENERGY IN THE CRYOGENIC PROPELLANT OF A NUCLEAR POWERED SPACE VEHICLE; TO ASSESS THE IMPACT OF THESE INTERACTIONS ON STAGE DESIGN; AND TO DEVELOP DESIGN CRITERIA FOR MINIMIZING THE EFFECTS OF THESE INTERACTIONS ON STAGE AND ENGINE PERFORMANCE. AN EXPERIMENTAL PROGRAM WILL GENERATE NUCLEAR ENERGY DEPOSITION AND LIQUID HYDROGEN STRATIFICATION DATA. ANALYTICAL PREDICTIONS OF NUCLEAR DEPOSITION RATES AND TEMPERATURE PROFILES FROM EXISTING COMPUTER PROGRAMS WILL BE COMPARED WITH THE EXPERIMENTAL DATA TO UP-DATE THE COMPUTER PROGRAMS OR DEVELOP REQUIRED NEW ONES. IT IS IMPERATIVE THAT ACCURATE ANALYTICAL PROCEDURES BE DEVELOPED AND VERIFIED, AND THAT COMPREHENSIVE EXPERIMENTAL DATA BE GENERATED TO PROVIDE THE BASIC INFORMATION REQUIRED TO DESIGN A STAGE WHICH WILL OPERATE RELIABLY IN THE UNIQUE ENVIRONMENT OF THE NUCLEAR ENGINE.

RTOP NO. 121-30-13 TITLE: NUCLEAR RADIATION MEASUREMENT AND EFFECTS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: SCHWARZ, F. C. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE IS THE ACQUISITION OF TECHNOLOGY FOR THE DEVELOPMENT OF RADIATION HARDENED INSTRUMENTATION FOR USE IN THE ENVIRONMENT OF THE NUCLEAR STAGE DURING GROUND TEST AND MISSION (FLIGHT) OPERATIONS. THE REQUIRED INSTRUMENTS WILL BE DEVELOPED OR IDENTIFIED BY (1) LITERATURE SEARCH, (2) OFF THE SHELF AVAILABLE, (3) TOTAL NEW DESIGN OR (4) MODIFICATION OF EXISTING SYSTEMS. THE

CANDIDATE INSTRUMENTS WILL THEN BE EVALUATED IN THE SEVEREST ENVIRONMENT TO BE ENCOUNTERED WHEN IN SERVICE USE I.E. RADIATION, VIBRATION, THERMAL ACOUSTIC ETC. THE RESULTS OF THIS RESEARCH IS REQUIRED TO FURNISH THE NECESSARY INSTRUMENTATION FOR GROUND TEST AND FLIGHT OPERATION OF THE NUCLEAR STAGE WHICH MAY BE THE OUTGROWTH OF THE CURRENT NUCLEAR FLIGHT MODULE DEFINITION WORK.

RTOP NO. 121-30-14 TITLE: STUDY FOR DUAL USE OF A NUCLEAR ENGINE  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: SCHWARZ, F. C. TEL. 205-453-1120  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE FEASIBILITY OF GENERATING ELECTRICAL POWER BY USING A NUCLEAR ENGINE AS A HEAT SOURCE. NEW EFFORTS WILL NOT BE PERFORMED IN ELECTRICAL POWER CONVERSION OR NUCLEAR ENGINE DEVELOPMENT. FEASIBILITY WILL BE DETERMINED BASED ON THE PREMISE THAT A SNAP CONVERSION SYSTEM WILL BE AVAILABLE DURING 1976 THRU 1980. SELECTION OF A SNAP CONVERSION SYSTEM WHICH AS BEEN USED WITH A NUCLEAR ENGINE THAT HAS PERFORMED ITS MISSION AS A PROPULSION MODULE AND IS AVAILABLE FOR USE AS A POSSIBLE HEAT SOURCE IS THE PRIMARY CONSIDERATION. FY 69 INVESTIGATION AND STUDY EFFORTS WILL DETERMINE IF TRADE-OFFS WARRANT ADDITIONAL EFFORTS IN THIS AREA.

SOME OF THE AREAS WHICH ARE TO BE CONSIDERED ARE AVAILABILITY OF A COMPATIBLE SNAP CONVERSION SYSTEM FOR CONVERSION OF HEAT TO A 25KW ELECTRICAL POWER OUTPUT, RADIATION PROFILE AROUND SENSITIVE ELECTRICAL EQUIPMENT WHEN NO HYDROGEN IS AVAILABLE FOR SHIELDING, SCHEMES FOR SWITCHING TO THE ELECTRICAL POWER GENERATING MADE PARAMETER PROFILE FOR COOL DOWN OF THE NUCLEAR ENGINE AND RESTART FOR ELECTRICAL POWER GENERATION, SYSTEM SCHEMATICS AND ESTIMATED ADDITIONAL WEIGHT REQUIRED TO OPERATE THE NUCLEAR ENGINE AS A DUAL MODE MODULE FOR PROPULSION/ELECTRICAL POWER GENERATION. INITIAL FEASIBILITY STUDY WILL INCLUDE A LISTING AND DISCUSSION OF NECESSARY DEVELOPMENTS FOR FOLLOW-ON EFFORTS.

RTOP NO. 122-29-20 TITLE: NUCLEAR ROCKET TECHNOLOGY  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: BARILE, S. TEL.  
TECHNICAL SUMMARY

RESEARCH WILL BE CONDUCTED IN TWO GENERAL AREAS OF NUCLEAR PROPULSION WITH EMPHASIS BEING PLACED ON SELECTING RESEARCH PROJECTS THAT MAY HAVE APPLICATION IN OTHER FIELDS. 1. STUDY THE FEASIBILITY OF GAS CORE NUCLEAR ROCKETS BY CONCENTRATING ON THE COAXIAL FLOW AND CURVED POROUS WALL CONCEPTS. THE ULTIMATE GOAL IS TO ACHIEVE A CRITICAL REACTOR WITH A SPECIFIC IMPULSE MUCH HIGHER THAN POSSIBLE WITH SOLID CORE NUCLEAR ROCKETS. 2. IN THE AREA OF SOLID CORE NUCLEAR ROCKETS, RESEARCH WILL BE LIMITED TO AREAS OUTSIDE THE REACTOR CORE. RESEARCH AREAS TO BE COVERED ARE: A. IRRADIATION EFFECTS ON SOLID LUBRICANTS; B. IRRADIATION EFFECTS ON THE LOW CYCLE

FATIGUE LIFE OF VARIOUS MATERIALS; C. DYNAMICS OF TURBOMACHINERY; D. ROCKET NOZZLE PROBLEMS.

RTOP NO. 124-07-10 TITLE: CONCEPTUAL DESIGN AND CONFIGURATION  
AERODYNAMICS OF ADVANCED MANNED LOGISTIC  
SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

INVESTIGATIONS WILL BE FOCUSED UPON DEVELOPMENT OF THE TECHNOLOGY BASE ESSENTIAL TO THE DESIGN OF MANNED LOGISTICS VEHICLES. THROUGH COMPUTER PROGRAMS AND WIND-TUNNEL TESTS, THE AERODYNAMIC CHARACTERISTICS OF A WIDE RANGE OF CONCEPTS WILL BE DETERMINED. MECHANICAL FEASIBILITY AND AERODYNAMIC EVALUATION OF LANDING AIDS WILL BE STUDIED THROUGH IN-HOUSE AND CONTRACTUAL EFFORTS. MISSION IMPACT UPON COSTS WILL BE STUDIED AS PART OF THE OVERALL CONCEPT DEVELOPMENT.

RTOP NO. 124-07-11 TITLE: AEROTHERMODYNAMICS OF MANNED ENTRY  
VEHICLES

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO PROVIDE INFORMATION REQUIRED FOR THE DESIGN AND TEST OF ADVANCED MANNED ENTRY VEHICLES WITH PARTICULAR REFERENCE TO ADVANCED LOGISTICS SYSTEMS. SPECIFICALLY, THE WORK WILL DEAL WITH LIFTING BODY CONFIGURATIONS, CONCEPTS FOR REUSEABLE SYSTEMS AND LAUNCH VEHICLES, LANDING AND RECOVERY AND REFURBISHABLE HEAT PROTECTION SYSTEMS. ANY ADDITIONAL APOLLO SUPPORT WILL BE INCLUDED WITHIN THIS RTOP. THIS WORK WILL BE DIRECTLY APPLICABLE TO THE DESIGN OF LOGISTICS SYSTEMS FOR PLACING PAYLOADS IN EARTH ORBIT WHEREIN THE PRIME OBJECTIVE IS TO REDUCE THE COST PER POUND IN ORBIT BY AT LEAST AN ORDER OF MAGNITUDE.

RTOP NO. 124-07-13 TITLE: AEROTHERMODYNAMIC AND ABLATIVE HEAT  
PROTECTION FOR VERY HIGH SPEED  
ATMOSPHERIC ENTRY

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP THE AEROTHERMODYNAMIC AND ABLATIVE HEAT PROTECTION TECHNOLOGY REQUIRED TO DESIGN UNMANNED SPACECRAFT FOR ENTRY INTO VENUS AND JUPITER AND BOTH MANNED AND UNMANNED SPACECRAFT CAPABLE OF REENTERING THE EARTH'S ATMOSPHERE AT SPEEDS IN EXCESS OF 50,000 FT/SEC. THE PROBLEM OF VERY HIGH SPEED

ENTRY WILL BE TACKLED BY (1) ATTEMPTING TO MINIMIZE THE TOTAL HEATING (CONVECTIVE PLUS RADIATIVE HEATING) BY PROPER CHOICE OF VEHICLE SHAPE, CHOICE OF HEAT SHIELD MATERIAL, ETC. (2) EVALUATION OF AVAILABLE MATERIALS IN SIMULATED ENVIRONMENTS COVERING A RANGE OF PLANETARY GASES, TOTAL HEATING RATES, AND RATIOS OF CONVECTIVE TO RADIATIVE HEATING AND (3) DEVELOPMENT OF NEW MATERIALS TAILORED TO PROVIDE MAXIMUM PROTECTION FROM PARTICULAR COMBINATIONS OF HEAT LOADS. THIS TECHNOLOGY IS REQUIRED FOR THE DESIGN OF PROBES WHICH WILL ENTER THE ATMOSPHERES OF VENUS AND THE OUTER PLANETS AND SPACECRAFT WHICH WILL EXPLORE THE PLANETS AND RETURN TO REENTER THE EARTH'S ATMOSPHERE. INCLUDED IN THIS RTOP IS SRT IN SUPPORT OF THE PLANETARY ATMOSPHERE EXPERIMENTS TEST.

RTOP NO. 124-07-13 TITLE: AEROTHERMODYNAMIC AND ABLATIVE HEAT PROTECTION FOR VERY HIGH SPEED ATMOSPHERIC ENTRY

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RESEARCH ARE TO DEVELOP TECHNIQUES AND APPARATUS FOR TESTING HEAT-SHIELD MATERIALS IN HIGH ENTHALPY AND HIGH-RADIATIVE HEATING ENVIRONMENTS ASSOCIATED WITH VERY HIGH SPEED ATMOSPHERIC ENTRIES AND TO DETERMINE THE RESPONSE OF HEAT-SHIELD MATERIALS TO SUCH CONDITIONS. THE RESEARCH WILL CONSIST OF INVESTIGATION OF MATERIAL RESPONSE BY ANALYTICAL STUDIES CONDUCTED IN-HOUSE AND ON A GRANT. IN ADDITION, EXPERIMENTAL EVALUATION OF MATERIAL RESPONSE TO HIGH RADIATIVE HEATING RATES WILL BE PERFORMED BY CONDUCTING CONTRACT TESTING. IN-HOUSE DESIGN STUDIES OF MEANS OF PRODUCING HIGH-ENTHALPY TEST STREAMS AND COMBINED RADIATIVE-CONVECTIVE HEATING TEST ENVIRONMENTS WILL BE CONDUCTED WITH EQUIPMENT FABRICATION BEING DONE ON CONTRACT.

RTOP NO. 124-07-14 TITLE: ADVANCED TECHNOLOGY IN AEROTHERMODYNAMICS AND ABLATIVE HEAT PROTECTION IN SUPPORT OF PROJECT VIKING

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE AERODYNAMIC HEAT INPUTS AND ABLATION MATERIAL REQUIREMENTS FOR BLUNTED CONES OF THE TYPE TO BE USED FOR ENTRY INTO THE MARS ATMOSPHERE (PROJECT VIKING). BOTH CONVECTIVE AND RADIATIVE HEATING WILL BE EXAMINED EXPERIMENTALLY (WIND TUNNELS AND SHOCK TUBES) AND THEORETICALLY. IN ADDITION TO BASIC THEORETICAL ANALYSES, ANALYTICAL RESEARCH WILL BE REQUIRED TO EXTRAPOLATE FROM THE TEST CONDITIONS TO THOSE THAT WILL ACTUALLY BE ENCOUNTERED DURING ENTRY. OF PARTICULAR INTEREST ARE THE CONDITIONS THAT GIVE RISE TO TURBULENT CONVECTIVE HEATING ON THE FOREBODY AND THE MAGNITUDE OF TURBULENT HEATING WHEN IT OCCURS. IN THE CASE OF RADIATIVE HEATING, IT IS THE NONEQUILIBRIUM EFFECTS THAT ARE OF CONCERN. EXTRAPOLATING OF EXISTING DATA CAN RESULT IN SERIOUS



ANOMALIES. DEPENDING ON WHAT DATA IS USED AND HOW IT IS EXTRAPOLATED, THE RELATIVE IMPORTANCE OF NONEQUILIBRIUM RADIATION GOES FROM NEGLIGIBLE TO DOMINANT. ANOTHER AREA OF UNCERTAINTY IN THE HEATING TECHNOLOGY OF MARS ENTRY VEHICLES IS AFTERBODY HEATING. HEATING RATES FROM ONE TO TEN PERCENT OF FOREBODY STAGNATION VALUES ARE QUOTED. ADDITIONAL EXPERIMENTAL DATA SHOULD HELP ELIMINATE THIS UNCERTAINTY. THE TYPES OF ABLATION MATERIALS REQUIRED TO PROTECT THE BASIC STRUCTURE AND PAYLOAD OF A MARS ENTRY CAPSULE ARE WELL KNOWN. ADDITIONAL TESTS WILL, NEVERTHELESS, BE REQUIRED TO COMPLETELY CHARACTERIZE THE PROPERTIES OF THE MATERIAL (OR MATERIALS) FINALLY SELECTED AND TO DETERMINE ITS PERFORMANCE WHEN SUBJECTED TO THE MAXIMUM EXPECTED TOTAL HEAT INPUT, HEATING RATE AND SHEAR. THESE TESTS ALONG WITH CONVECTIVE AND RADIATIVE HEATING MEASUREMENTS WILL ALLOW THE SPECIFICATION OF THE ABLATION MATERIAL THICKNESS NECESSARY TO MAINTAIN THE SUPPORTING STRUCTURE AT A TEMPERATURE LESS THAN SOME PRESCRIBED VALUE.

RTOP NO. 124-07-15 TITLE: VENUS AND JUPITER PLANETARY ENTRY  
AEROTHERMODYNAMICS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

#### TECHNICAL SUMMARY

FUTURE PLANETARY MISSIONS WILL REQUIRE SPACECRAFT WHICH CARRY AND DEPLOY ATMOSPHERIC ENTRY PROBES FOR ON-SITE OBSERVATIONS. THE INTENSE CONVECTIVE AND RADIATIVE HEAT FLUX AND GAS INPUT FORCES ENCOUNTERED BY AN ATMOSPHERIC ENTRY PROBE IN THE BREAKING MANUEVER MUST BE PREDICTED ACCURATELY TO INSURE A HEAT SHIELD AND STRUCTURE CAPABLE OF PROTECTING THE INSTRUMENTED SCIENCE PAYLOAD. THE OBJECTIVE, THEREFORE, OF THIS TASK IS TO BE ABLE TOPREDICT THE ADVERSE BRAKING MANUEVER ENVIRONMENT. THE AEROTHERMODYNAMIC PROBLEMS OF ENTRY INTO THE JUPITER ATMOSPHERE WILL BE EMPHASIZED DURING THE NEXT SEVERAL YEARS OF EFFORT. WORK DONE TO DATE, SOME OF WHICH CAN BE USED DIRECTLY FOR MARS AND VENUS ENTRY STUDIES, IS A NECESSARY STEP TO THE DEVELOPMENT OF AN UNDERSTANDING OF THE JUPITER CASE. A SYSTEMATIC CORRELATION OF EXPERIMENTAL OBSERVATION OF THE AEROTHERMODYNAMIC EFFECTS OF MODELS OF PLANETARY ENTRY PROBES PLACED IN A SIMULATED ENTRY ENVIRONMENT MUST BE MADE. THESE PHYSICAL OBSERVATIONS ARE INTERPRETED AND GENERALIZED BY COMPARISION WITH THEORETICAL FLOW-FIELD AND RADIATION-FIELD MATHEMATICAL MODELS, CONTINUOUSLY DEVELOPED TO INCORPORATE THE MOST RECENT KNOWLEDGE OF PLANETARY ATMOSPHERIC GAS THERMOCHEMICAL AND TRANSPORT PROPERTIES. THESE AEROTHERMODYNAMIC HEATING STUDIES WILL BE SUPPLIMENTED BY SOME ANALYSIS OF VEHICLE MOTION DURING ENTRY. THE FOLLOWING WORK WHICH IS ESSENTIAL TO ACHIEVING THE OBJECTIVE HAS BEEN DONE: 1) VACUUM ULTRAVIOLET SPECTRA OF SHOCK LAYER PLASMAS HAVE BEEN DETERMINED; 2) TOTAL AND SPECTRAL INTENSITY OF SHOCK HEATED JOVIAN GASES HAVE BEEN RECORDED; 3) PLANETARY ENTRY BODY HEATING RATES IN AIR AND VENUS ATMOSPHERIC GAS HAVE BEEN DETERMINED; 4) CONVECTIVE HEATING DISTRIBUTION ON 60 DEG HALF-ANGLE BLUNTED CONES HAVE BEEN MEASURED; 5) BLUNT BODY INVISID FLOW-VICLA STUDIES WERE CONDUCTED; 6) VISCOUS SHOCK LAYER ANALYSIS WAS PERFORMED AND ; 7) HYPERVELOCITY LABORATORY DEVELOPMENT CONTINUED AT AN APPROPRIATE PACE.



RTOP NO. 124-07-17 TITLE: GENERALIZED SPACE VEHICLE AERODYNAMICS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

TO DETERMINE BY THEORETICAL AND EXPERIMENTAL METHODS THE AERODYNAMIC CHARACTERISTICS OF SHARP AND BLUNT NOSED CONFIGURATIONS FOR BALLISTIC AND LIFTING ATMOSPHERIC ENTRY BODIES IN VARIOUS SPEED RANGES AND TO STUDY THE DYNAMICS OF BODIES AND CONTROL SYSTEMS IN ORDER TO DERIVE METHODS FOR CALCULATING THE MOTION OF BODIES; AND TO DEVELOP METHODS TO REDUCE THE UNCERTAINTIES ASSOCIATED WITH PREDICTING THE AEROTHERMODYNAMICS OF EXPENDABLE AND REUSABLE LAUNCH VEHICLES.

RTOP NO. 124-07-17 TITLE: GENERALIZED SPACE VEHICLE AERODYNAMICS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP METHODS OF PREDICTING THE AERODYNAMIC CHARACTERISTICS OF SHARP AND BLUNT NOSED SPACECRAFT CONFIGURATIONS, THE DYNAMICS OF BODIES AND CONTROL SYSTEMS, AND THE AEROTHERMODYNAMICS OF LAUNCH VEHICLES. IN ADDITION THIS RTOP WILL COVER ALL DOD REQUESTS FOR SUPPORT APPROPRIATE TO THE SPACE VEHICLES PROGRAM. EXPERIMENTAL PROGRAMS FOR DETERMINING THE AERODYNAMIC AND DYNAMICS OF SPACECRAFT AND LAUNCH VEHICLE CONFIGURATIONS WILL BE CONDUCTED IN SUPERSONIC, HYPERSONIC AND ARC JET WIND TUNNELS. METHODS WILL BE DEVELOPED TO PREDICT AERODYNAMIC AND DYNAMICS BEHAVIOR AND DETERMINE THE IMPORTANCE OF PARAMETERS INFLUENCING THE AERODYNAMICS AND DYNAMIC BEHAVIOR OF SPACECRAFT. RESULTS WILL BE USED TO DEVELOP ADVANCED, REUSEABLE SPACECRAFT AND LAUNCH VEHICLES.

RTOP NO. 124-07-18 TITLE: GENERALIZED REENTRY HEATING AND HEAT PROTECTION TECHNOLOGY  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK INCLUDES THE DEVELOPMENT OF THE BASIC REENTRY HEATING AND HEAT PROTECTION TECHNOLOGY REQUIRED FOR A BROAD RANGE OF ENVIRONMENTS. FLIGHT VELOCITIES OF INTEREST RANGE FROM 20 K FT/SEC TO 50 K FT/SEC AND ABOVE FOR ENTRY INTO VARIOUS ATMOSPHERES. IN THE APPROPRIATE VELOCITY REGIME, THE AREAS COVERED INCLUDE HOT GAS RADIATION HEAT TRANSFER, THE COUPLING BETWEEN RADIATION AND THE ABLATION PROCESS, THE TOTAL ABLATION PROCESS, BOUNDARY LAYER TRANSITION INCLUDING ABLATION EFFECTS, AND TURBULENT HEAT TRANSFER WITH AND WITHOUT MASS ADDITION. LIKELY ULTIMATE APPLICATION OF THIS TECHNOLOGY INCLUDES A VARIETY OF MISSIONS REQUIRING EARTH ENTRY AND CERTAIN PLANETARY ENTRY MISSIONS. THE ANALYTICAL APPROACH TO THIS WORK INCLUDES THE DEVELOPMENT AND EXPLOITATION OF COMPREHENSIVE NUMERICAL SOLUTIONS. THE EXPERIMENTAL EFFORT WILL EMPLOY EXISTING GROUND FACILITIES, SOME OF WHICH REQUIRE SOME MODIFICATIONS. EXISTING FLIGHT DATA WILL ALSO BE UTILIZED IN THIS WORK AND AN EFFORT

TO DEFINE CRITICAL RESEARCH FLIGHT EXPERIMENTS WILL BE PURSUED.

RTOP NO. 124-07-18 TITLE: GENERALIZED REENTRY HEATING AND ABLATIVE  
HEAT PROTECTION

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO PROVIDE GENERALIZED ENTRY HEATING AND ABLATIVE HEAT PROTECTION RESEARCH NEEDED FOR DESIGN AND EVALUATION OF FUTURE SPACE VEHICLES. SPECIFICALLY, THE WORK WILL DEAL WITH GROOVE PATTERNS ASSOCIATED WITH ABLATING CONICAL BODIES, BOUNDARY LAYER TRANSITION, TECHNIQUES OF PREDICTING ABLATIVE MATERIAL PERFORMANCE AS FUNCTIONS OF MATERIAL PROPERTIES AND HEATING ENVIRONMENT, AND IMPROVEMENT OF FACILITIES REQUIRED TO SIMULATE CONVECTIVE, RADIATIVE AND COMBINED HEATING ENVIRONMENTS. GENERALIZED HEATING AND MATERIAL PERFORMANCE INFORMATION IS REQUIRED IN THE DESIGN OF PLANETARY ENTRY VEHICLES, SPACE POWER SYSTEMS AND HIGH SPEED EARTH ENTRY CONFIGURATIONS.

RTOP NO. 124-07-19 TITLE: SYSTEMS FOR TERMINAL DESCENT AND LANDING  
ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THE RESEARCH DESCRIBED HEREIN IS TO ADVANCE THE TECHNOLOGY OF DESCENT AND LANDING FOR SPACECRAFT SYSTEMS USING AUXILIARY DEVICES TO PROVIDE DRAG, LIFT, AND CONTROLLABILITY IN ADDITION TO THAT PROVIDED BY THE BASIC SPACECRAFT. SUCH DEVICES CAN LEAD TO IMPROVED MISSION CAPABILITY, LOWER WEIGHT AND COST, AND MISSION GROWTH POTENTIAL. APPLICATIONS INCLUDE BOTH MANNED AND UNMANNED ENTRY SPACECRAFT, DATA RETURN CAPSULES, LOGISTICS VEHICLES, AND RECOVERABLE BOOSTER STAGES. ANALYTICAL, WIND TUNNEL, AND FLIGHT TESTS (BOTH SMALL SCALE AND LARGE SCALE) ARE BEING USED TO EXPLORE VARIOUS SYSTEMS. THE RESEARCH WILL PROVIDE FEASIBILITY DEMONSTRATIONS, EXPLORE PROBLEMS AND LIMITATIONS, AND PROVIDE A BACKLOG OF TECHNICAL DATA FOR USE IN EVALUATION, TRADE-OFF STUDIES, AND SYSTEM SELECTION AND DESIGN FOR ADVANCED SPACE MISSIONS.

RTOP NO. 124-07-20 TITLE: PARAWING TECHNOLOGY PROGRAM

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

A PARAWING PROJECT REVIEW WAS HELD AT THE LANGLEY RESEARCH CENTER ON JUNE 18, 1969 WITH PERSONNEL FROM NASA HEADQUARTERS, MANNED SPACECRAFT CENTER, AND FLIGHT RESEARCH CENTER PARTICIPATING. THIS REVIEW RESULTED IN AN AGREEMENT THAT A MAJOR REDIRECTION OF THE PARAWING PROJECT IS IN ORDER. IT WAS FURTHER AGREED THAT DISCUSSIONS WOULD TAKE PLACE BETWEEN LANGLEY RESEARCH CENTER AND MANNED SPACECRAFT CENTER TO DERIVE A SUITABLE PROGRAM WITH EMPHASIS ON

IN-HOUSE EFFORTS. HOWEVER, A CERTAIN AMOUNT OF R AND D FUNDS WILL BE REQUIRED FOR THE NORTHRUP VENTURA CONTRACT TO EFFECTIVELY CLOSE OUT THAT EFFORT AND DOCUMENT PAST WORK EVEN IF NO NEW WORK IS STARTED.----

RTOP NO. 124-07-22 TITLE: EXPLORATORY INVESTIGATIONS OF PROBLEMS  
ASSOCIATED WITH TERMINAL DESCENT AND  
LANDING OF MANNED SPACECRAFT CONCEPTS AND  
DESCENT SYSTEMS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: REED, R. D. TEL. 805-258-3311

TECHNICAL SUMMARY

MODELS OF SPACECRAFT SHUTTLE CONCEPTS ARE BEING AIRLAUNCHED AND THEN GLIDED TO A LANDING AT EDWARDS, CALIF. MODELS ARE FLOWN FIRST BY RADIO-CONTROL AND LATER BY PILOTS IF PROVEN PROMISING ENOUGH FOR MANNED INVESTIGATION. BASIC OBJECTIVES ARE AS FOLLOWS: 1. TO STUDY AND DEFINE THE OPERATIONAL PROBLEMS ASSOCIATED WITH MANNED CONTROL OF A SPACECRAFT/FLEXIBLE-WING (PARAWING) TERMINAL LANDING SYSTEM. INFORMATION WILL BE SOUGHT TO AID IN THE DEFINITION AND DESIGN OF ADVANCED SPACECRAFT LAND RECOVERY SYSTEMS SUCH AS REQUIRED FOR THE LARC AND MSC DECOUPLED MODE CONFIGURATIONS. 2. TO STUDY THE SUBSONIC FLIGHT CHARACTERISTICS OF A HIGH FINENESS-RATIO LIFTING BODY (DART-LIKESHUTTLECRAFT SPACECRAFT CONFIGURATION), AND THE BODY WITH SKEWED WING, AND SWITCH-BLADE WING; AND TO STUDY THE TRANSIENT EFFECTS DURING WING DEPLOYMENT. ATTENTION WILL BE GIVEN TO SCALE EFFECTS BETWEEN SMALL-SCALE (5 FEET, 10 POUNDS), AND LARGE-SCALE (30 FEET, 700 TO 1,500 POUNDS) RADIO-CONTROLLED MODELS.

RTOP NO. 124-07-23 TITLE: DECELERATOR TECHNOLOGY FOR PLANETARY  
PROBE/LANDER TERMINAL DESCENT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

TO PROVIDE THE TECHNOLOGY REQUIRED FOR EFFICIENT DESIGN AND DEVELOPMENT OF PARACHUTES, OTHER TOWED DECELERATORS, AND ATTACHED DECELERATORS HAVING APPLICATION TO PLANETARY ENTRY AND LANDING. TO PROVIDE AN UNDERSTANDING OF SIMILARITY LAWS, DEPLOYMENT AND INFLATION DYNAMICS, AERODYNAMIC PERFORMANCE AND STABILITY OF DECELERATOR AND DECELERATOR-VEHICLE COMBINATIONS. TO DEVELOP AN UNDERSTANDING OF THE FLIGHT BEHAVIOR AND FABRICATION REQUIREMENTS OF FLEXIBLE FABRIC MATERIALS THAT ARE UNCOATED AND MATERIALS THAT ARE COATED TO REDUCE POROSITY OR PROVIDE PASSIVE THERMAL PROTECTION. COMPREHENSIVE IN-HOUSE AND CONTRACT ANALYTICAL AND WIND TUNNEL TEST PROGRAMS WILL LEAD TO SELECTED FLIGHT TESTS FOR DECELERATOR EVALUATION AND TECHNOLOGY DEMONSTRATION. THE RESULTS WILL SUPPORT DECELERATOR DESIGN FOR VIKING AND PROVIDE THE BASIS FOR DECELERATOR CHOICE AND DESIGN FOR LATER ADVANCED MISSIONS.

RTOP NO. 124-07-24 TITLE: MANNED SPACE SHUTTLE (CATEGORY I):  
CONFIGURATION, PERFORMANCE AND  
AEROTHERMAL STUDIES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

SEVERAL MANNED SPACE SHUTTLE CONCEPTS OF THE PARTIALLY OR FULLY REUSABLE TYPE ARE CURRENTLY BEING CONSIDERED BY NASA TO SUPPORT FUTURE SPACE STATIONS AND SPACE BASE OPERATIONS, AS WELL AS FOR SHORT DURATION INDEPENDENT MISSIONS. TO IDENTIFY THE MOST PROMISING CONCEPT AND ESTABLISH FEASIBILITY THERE IS A NEED TO EVALUATE CONFIGURATIONS REPRESENTATIVE OF CANDIDATE CONCEPTS, IDENTIFY PROBLEMS AND SOLUTIONS, AND ADVANCE THE TECHNOLOGY WHERE REQUIRED. TO ACHIEVE THIS GOAL NECESSITATES PARALLEL AND COORDINATED EFFORT IN SEVERAL TECHNOLOGY AREAS. WORK UNDER THIS RTOP ADDRESSES KEY ISSUES OF IMMEDIATE IMPORTANCE IN THE BROAD AREA OF CONFIGURATION ASSESSMENT, PERFORMANCE, AND AEROTHERMAL STUDIES. THIS WORK WILL BE DONE IN THE FOLLOWING MANNER IN CONJUNCTION WITH WORK UNDER OTHER LANGLEY SPACE SHUTTLE RTOP'S IN THE AREAS OF STRUCTURES, THERMAL PROTECTION, AND MISSION ANALYSIS. 1. THROUGH SELECTIVELY EXAMINING THE AEROTHERMAL AND STABILITY AND CONTROL CHARACTERISTICS OF REPRESENTATIVE CONCEPTS OVER THE TOTAL SPECTRUM OF SYSTEM ENVIRONMENTS (ASCENT-ORBIT-RETURN-LANDING), A NARROWING OF THE SHUTTLE SYSTEM CANDIDATES WILL BE EFFECTED. 2. THROUGH MORE REFINED ANALYSIS OF THE REMAINING CANDIDATES, THE OPTIONS WILL BE SYSTEMATICALLY NARROWED TO A SINGLE BEST CHOICE. BOTH IN-HOUSE AND CONTRACTUAL EFFORTS WILL BE BROUGHT TO BEAR.

RTOP NO. 124-07-25 TITLE: MANNED SPACE SHUTTLE (CATEGORY II):  
CONFIGURATION, PERFORMANCE AND  
AEROTHERMAL STUDIES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

SEVERAL MANNED SPACE SHUTTLE CONCEPTS OF THE PARTIALLY OR FULLY REUSABLE TYPE ARE CURRENTLY BEING CONSIDERED BY NASA TO SUPPORT FUTURE SPACE STATIONS AND SPACE BASE OPERATIONS, AS WELL AS FOR SHORT DURATION INDEPENDENT MISSIONS. TO IDENTIFY THE MOST PROMISING CONCEPT AND ESTABLISH FEASIBILITY THERE IS A NEED TO EVALUATE CONFIGURATIONS REPRESENTATIVE OF CANDIDATE CONCEPTS, IDENTIFY PROBLEMS AND SOLUTIONS AND ADVANCE THE TECHNOLOGY WHERE REQUIRED. TO ACHIEVE THIS GOAL NECESSITATES PARALLEL AND COORDINATED EFFORT IN SEVERAL TECHNOLOGY AREAS. WORK UNDER THIS RTOP COVERS THE DETAILED RESEARCH AND TESTING REQUIRED IN THE CONFIGURATION ASSESSMENT, PERFORMANCE, AND AEROTHERMAL STUDIES TO SUPPORT DEVELOPMENT OF THE FINAL SELECTION (MADE PRIMARILY FROM STUDIES UNDER THE COMPANION CATEGORY I RTOP WITH SAME TITLE). THIS WORK WILL BE DONE IN CONJUNCTION WITH WORK UNDER OTHER LANGLEY SPACE SHUTTLE RTOP'S IN THE AREAS OF STRUCTURES, THERMAL PROTECTION, AND MISSION ANALYSIS. BOTH IN-HOUSE AND CONTRACTUAL EFFORTS WILL BE BROUGHT TO BEAR.

RTOP NO. 124-07-26 TITLE: MANNED SPACE SHUTTLE (CATEGORY I):  
DEVELOPMENT OF THERMAL PROTECTION SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THE OUTLINED PROGRAM IS TO INVESTIGATE THERMAL PROTECTION SYSTEMS FOR MANNED SPACE SHUTTLES, TO ASSESS THE ADEQUACY OF EXISTING TECHNOLOGY, AND TO IDENTIFY AND IMPLEMENT REQUIRED DEVELOPMENTS. THIS WILL BE ACCOMPLISHED PRIMARILY BY CONTRACT WORK SUPPORTED BY IN-HOUSE STUDIES AND TESTING. THREE TYPES OF HEAT SHIELDS WILL BE CONSIDERED: LOW-COST ABLATIVE SHIELDS, NON-METALLIC RADIATIVE-INSULATIVE SHIELDS, AND METALLIC RADIATIVE SHIELDS. FIBROUS INSULATION MATERIALS, NON-DESTRUCTIVE TEST TECHNIQUES, AND SOME ASPECTS OF FILM AND TRANSPIRATION COOLING WILL ALSO BE INVESTIGATED. PARAMETRIC HEAT-SHIELD STUDIES WILL ALSO BE MADE TO PROVIDE RATIONAL AND UP-TO-DATE ESTIMATES OF THE WEIGHT AND COST OF SYSTEMS INVOLVING ABLATORS, RADIATORS, INSULATORS, AND ACTIVE COOLING. LARGE-SCALE THERMAL PROTECTION SYSTEMS WILL BE DESIGNED, FABRICATED, AND TESTED TO VALIDATE ANALYTICAL RESULTS, WEIGHTS AND POSSIBLY COSTS. THE RESULTS OF THESE STUDIES WILL PROVIDE INFORMATION WHICH WILL SERVE AS A BASIS FOR THE SELECTION AND DESIGN OF THERMAL PROTECTION SYSTEMS FOR MANNED SPACE SHUTTLES.

RTOP NO. 124-07-27 TITLE: MANNED SPACE SHUTTLE (CATEGORY I):  
OPERATIONAL ANALYSIS STUDIES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THIS RTOP IS ONE COMPONENT OF THE LANGLEY COORDINATED SPACE SHUTTLE TECHNOLOGY PROGRAM. THE WORK WILL INITIALLY SUPPORT THE SPACE SHUTTLE RTOP'S ON AEROTHERMAL, AND STABILITY AND CONTROL CHARACTERISTICS AND ON THERMAL PROTECTION SYSTEMS AS THE OPTIONS ARE NARROWED FROM MANY SPACE SHUTTLE CANDIDATES TO A FEW BY SELECTIVELY EXAMINING THE CHARACTERISTICS OF REPRESENTATIVE CLASSES OF CONCEPTS OVER THE TOTAL SPECTRUM OF SYSTEM ENVIRONMENTS. THE INITIAL PHASE OF THIS WORK WILL MAINLY BE CONCERNED WITH TRAJECTORY ANALYSIS. AS THE OPTIONS ARE NARROWED, THE SCOPE OF THE OPERATIONAL ANALYSIS STUDIES WILL BROADEN TO ENCOMPASS ALL PHASES OF THE MISSION FROM LAUNCH TO LANDING AND TURNAROUND.

RTOP NO. 124-07-28 TITLE: MANNED SPACE SHUTTLE (CAT. I):  
AEROTHERMODYNAMICS OF AN AIRPLANE-LIKE  
CONCEPT

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

TO DETERMINE THE AEROTHERMODYNAMIC CHARACTERISTICS OF AN AIRPLANE-LIKE SPACE SHUTTLE VEHICLE SUCH AS PROPOSED BY THE MANNED SPACE FLIGHT CENTER. INITIAL EMPHASIS IS ON EXPLORATORY DATA REQUIRED TO DETERMINE FEASIBILITY OF THIS CONCEPT, AND TO IDENTIFY AT

AN EARLY DATE PROBLEM AREAS AND INDICATE THE LIKLIHOOD FOR SOLUTIONS. ACCORDINGLY, AERODYNAMIC (FORCE AND MOMENT) DATA WILL BE OBTAINED AT  $M = .25$  TO 10 AND QUALITATIVE HEATING DATA WILL BE OBTAINED AT  $M = 15$ . THESE DATA WILL PERMIT COMPARISON OF THIS CONCEPT WITH THE OTHER CONCEPTS BEING PROPOSED FOR A LOW-COST SPACE TRANSPORTATION SYSTEM. IF THIS COMPARISON IS ENCOURAGING, MORE DETAILED STUDIES WILL BE MADE TO AID IN THE REFINEMENT OF THE CONCEPT.

RTOP NO. 124-07-29 TITLE: MANNED SPACE SHUTTLE: NON-METALLIC HEAT SHIELDS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

TO DETERMINE THE CHARACTERISTICS OF CANDIDATE MATERIALS FOR USE IN THE HEAT-SHIELD DESIGN OF A SPACE SHUTTLE VEHICLE. MATERIALS SUCH AS POLYBENZIMIZOL, POLYPHENYLENE, POLYIMIDE, AS WELL AS CARBON AND SILICA BASE MATERIALS WILL BE TESTED IN ARC-JET FACILITIES CAPABLE OF DUPLICATING A NUMBER OF FULL-SCALE FLIGHT CONDITIONS. EMPHASIS WILL BE UPON THE EVALUATION AND DEVELOPMENT OF NON-METALLIC MATERIALS WHICH REQUIRE LITTLE OR NO REFURBISHMENT.

RTOP NO. 124-07-30 TITLE: EARTH ORBIT LOGISTICS - THERMAL PROTECTION SYSTEMS AND MATERIALS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: GREENSHIELDS, D. H. TEL. 713-483-3676

TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS PLAN IS THE DEVELOPMENT OF PRACTICAL THERMAL PROTECTION MATERIALS AND SYSTEMS CONCEPTS WHICH REFLECT AN OPTIMUM COMBINATION OF REUSABILITY, WEIGHT, COST, TURNAROUND CERTIFICATION EFFORT, AND SENSITIVITY TO OFF-NOMINAL ENTRY CONDITIONS, AND THE CHARACTERIZATION OF THESE SYSTEMS AND THE ASSOCIATED MATERIALS TO ALLOW THEIR USE IN VEHICLE DESIGN. PRIMARY EMPHASIS WILL BE PLACED ON NON-METALLIC MATERIALS, WHICH ARE LESS SENSITIVE TO ABSOLUTE TEMPERATURE LEVELS AND CAN BE USED IN SURFACE INSULATION SYSTEMS DESIGNS OR IN REUSABLE HIGH TEMPERATURE LEADING EDGES AND NOSE CAPS. THE ACHIEVEMENT OF THIS GOAL REQUIRES THE DEVELOPMENT OF COMPREHENSIVE METHODOLOGY FOR THERMAL/STRUCTURAL TRADEOFF AND OPTIMIZATION, A REALISTIC APPRAISAL OF REUSABILITY FOR VARIOUS ENTRY CONDITIONS, AND A PRACTICAL APPROACH TO THE OPERATIONAL PROBLEM OF REUSE CERTIFICATION. THE TECHNICAL EFFORTS REQUIRED TO SUPPORT THIS DEFINITION INCLUDE: (A) RELATIVE COST AND WEIGHT DATA BASED ON THE FABRICATION OF PROTOTYPE SYSTEMS.

RTOP NO. 124-07-31 TITLE: PRELIMINARY DESIGN OF A MANNED SUBSCALE  
SPACE SHUTTLE FLIGHT TEST VEHICLE

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: MCTIGUE, J. G. TEL. 805-258-3311

TECHNICAL SUMMARY

INFORMATION REGARDING THE PERFORMANCE AERODYNAMICS, STABILITY, CONTROL, AND HANDLING QUALITIES FOR THE CRITICAL TERMINAL PHASE OF FLIGHT MUST BE PROVIDED FOR THE SELECTED SPACE SHUTTLE VEHICLE CONFIGURATION. THIS RTOP COVERS AN IN-HOUSE PRELIMINARY DESIGN FOR A FLIGHT TEST VEHICLE WHICH CAN PROVIDE THIS INFORMATION IN THE LOW TO MACH 2+ SPEED RANGE IN A TIMELY MANNER AND WITH A LOW COST, MANNED FLIGHT PROGRAM SIMILAR TO THE CURRENT FRC LIFTING BODY PROGRAM. THIS DESIGN EFFORT WILL ALSO DEFINE THE FLIGHT TEST VEHICLE SIZE, WEIGHT, PERFORMANCE CHARACTERISTICS, DESIGN LIMITS AND CRITERIA, AND OPERATIONAL ENVELOPE. AT THE COMPLETION OF THIS DESIGN EFFORT AND DEFINITION OF A SINGLE SPACE SHUTTLE CONFIGURATION BY NASA, THE FRC WILL BE IN A POSITION TO RELEASE AN RFP FOR THE DETAILED DESIGN AND CONSTRUCTION OF A FLIGHT TEST VEHICLE.

RTOP NO. 124-07-32 TITLE: MANNED SPACE SHUTTLE (CAT. II) TERMINAL  
FLIGHT OPERATIONS ANALYSIS (SIMULATION OF  
TERMINAL FLIGHT PROBLEMS IN ACTUAL FLIGHT

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: LAYTON, G. P. TEL. 805-258-3311

TECHNICAL SUMMARY

THE PURPOSE OF THIS STUDY IS TO DEFINE THE SPECIAL REQUIREMENTS TO BE MET BY BOTH THE LIFTING REENTRY VEHICLE, AND THE AIR TRAFFIC CONTROL SYSTEM TO ALLOW OPERATIONAL SPACE SHUTTLE FLIGHTS. THIS WORK INCLUDES STUDY OF VARIABLE GEOMETRY, IFR RECOVERY TECHNIQUES, AND AIR TRAFFIC PROCEDURES.

RTOP NO. 124-07-34 TITLE: EARTH ORBIT LOGISTICS SPACECRAFT -  
AERODYNAMIC OPERATIONS ANALYSIS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: BASS, R. TEL. 713-483-2381

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE ANALYTICAL STUDIES AND EXPERIMENTAL WIND TUNNEL TEST EVALUATION STUDIES FOR THE DEFINITION OF VEHICLE AERODYNAMICS, PERFORMANCE, AND STABILITY AND CONTROL CHARACTERISTICS. THESE STUDIES WILL INCLUDE THE ENTIRE FLIGHT SPECTRUM ENCOUNTERED BY THE LOGISTICS SPACECRAFT CONFIGURATIONS AS IDENTIFIED BY THE FOLLOWING STUDY AREAS: 1. LAUNCH VEHICLES STUDIES 2. LAUNCH ASCENT ABORT STUDIES 3. STAGE SEPARATION STUDIES 4. ORBITAL PLUME IMPINGEMENT AND RARIFIED GAS DYNAMIC STUDIES 5. ATMOSPHERIC ENTRY STUDIES 6. TRANSITION, CRUISE AND LANDING, FERRY PERFORMANCE, AND STABILITY AND CONTROL STUDIES.



RTOP NO. 124-07-35 TITLE: EARTH ORBIT LOGISTICS SPACECRAFT -  
AEROTHERMODYNAMICS OPERATIONS ANALYSIS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: GOODRICH, W. D. TEL. 713-483-2326

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK IS TO TAKE THE EXISTING EXPERIMENTAL HEAT TRANSFER RATE AND PRESSURE DATA FOR THE MSC CONFIGURATIONS AND TO INTERPRET THESE RESULTS SUCH THAT MEANINGFUL FLIGHT PREDICTIONS CAN BE MADE. TO UNDERSTAND THE BEHAVIOR OF SUCH PHENOMENA AS TURBULENT TRANSITION, LOCAL FLOW INTERACTIONS, SHOCK IMPINGEMENT, SEPARATED FLOW AND VORTEX GENERATION FOR A CASE WHERE EXTREME SCALING OF DATA IS REQUIRED PRESENTS A FORMIDABLE PROBLEM TO THE ANALYST FOR RELATIVELY SIMPLE CONFIGURATIONS.

RTOP NO. 124-07-37 TITLE: AEROTHERMODYNAMIC STUDY OF SPACE SHUTTLE  
VEHICLE CONCEPTS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: GOODRICH, W. D. TEL. 205-453-1115

TECHNICAL SUMMARY

OBJECTIVE: TO CONDUCT SUPPORTING TECHNOLOGY ACTIVITIES IN THE AEROTHERMODYNAMICS AREA APPLICABLE TO THE REUSABLE SPACE SHUTTLE VEHICLE CONCEPT. APPROACH: A SET OF REPRESENTATIVE CANDIDATES FOR THE SPACE SHUTTLE HAS BEEN INVESTIGATED IN CONJUNCTION WITH CONTRACTOR STUDIES, WITH THE EVENTUAL GOAL OF IDENTIFYING THE MOST PROMISING CONCEPT FOR FURTHER DEVELOPMENT. AN IN-HOUSE CONCEPT HAS BEEN ESTABLISHED FOR STUDY IN ORDER FOR MSFC TO BE EFFECTIVE IN ASSESSMENT AND JUDGEMENT OF CONTRACTOR WORK ALREADY DONE AND IN ORDER TO INSURE COMPETENT MANAGEMENT IN FUTURE STUDIES. WORK UNDER THIS RTOP IS DIRECTED TO KEY POINTS OF THE CONCEPT IN THE AREA OF AEROTHERMODYNAMIC CONFIGURATION DEVELOPMENT, AND PROCEEDS PARALLEL AND INTEGRATED WITH PERTINENT STUDIES IN OTHER DISCIPLINARY AREAS. THE STUDY APPROACH IS BASED ON BOTH ANALYTICAL AND EXPERIMENTAL INFORMATION. THE OPTIMIZATION PROCESS THROUGH WHICH THE CANDIDATE IS SUBJECTED WILL RESULT IN MODIFICATIONS THEREOF AND WILL PRODUCE THE METHODS AND TECHNIQUES NEEDED TO INSURE THE MOST EFFICIENT DESIGN.

RTOP NO. 124-08-10 TITLE: ADVANCED STRUCTURAL CONCEPTS AND  
MATERIALS APPLICATIONS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOPE NEW STRUCTURAL CONCEPTS AND ADVANCED MATERIALS INCLUDING COMPOSITES, FABRICS, AND MEMBRANE MATERIALS FOR FLEXIBLE OR RIGID SPACE STRUCTURAL APPLICATIONS. THE WORK CONSISTS OF ANALYTICAL AND EXPERIMENTAL STUDIES OF FILAMENTARY COMPOSITE MATERIALS, EVALUATION, CHARACTERIZATION, AND STUDY OF FABRIC MATERIALS TO BETTER DEFINE MATERIAL CAPABILITES AND STRUCTURAL REQUIREMENTS, DEVELOPEMENT OF ADVANCED POLYMERS FOR SPACECRAFT APPLICATIONS, EVALUATION AND IMPROVEMENT OF FASTENING METHODS FOR HIGH-PERFORMANCE STRUCTURAL MATERIALS, DEVELOPMENT OF UNIQUE



MECHANISMS APPLICABLE TO SPACECRAFT HARDWARE, AND INVESTIGATION OF SELF-ERECTABLE STRUCTURES FROM A NICKEL-TITANIUM MATERIAL. A PORTION OF THIS PROGRAM WILL BE ACCOMPLISHED BY CONTRACT TO SUPPORT THE IN-HOUSE EFFORTS. THE RESULTS OF THESE STUDIES WILL LEAD TO A BETTER UNDERSTANDING OF CAPABILITIES OF ADVANCED FILAMENTARY AND FABRIC MATERIALS THAT MAY LEAD TO POTENTIAL IMPROVEMENTS IN STRUCTURAL EFFICIENCY, WILL PROVIDE FEASIBILITY FOR PERFORMING DEFINED MISSIONS, OR WILL IDENTIFY NEW APPLICATIONS OR MISSION POSSIBILITIES.

RTOP NO. 124-08-11 TITLE: PRESSURE VESSELS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: SMITH, G. T. TEL. 216-433-4000  
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL BE DIRECTED TOWARD PROVIDING DATA AND TECHNIQUES FOR THE DESIGN OF LOW COST, HIGH PERFORMANCE, RELIABLE PRESSURE VESSELS. BOTH METALLIC AND FILAMENT-WOUND VESSEL TECHNOLOGY WILL BE ESTABLISHED AND REFINED. METALLIC PRESSURE VESSEL TECHNOLOGY WILL INCLUDE: 1. DEVELOPMENT OF SYSTEMATIC METHODS OF DESIGN, INCORPORATING RECENT FRACTURE MECHANICS TECHNOLOGY. 2. IDENTIFICATION AND EVALUATION OF ALLOYS FOR CRYOGENIC APPLICATION. 3. IMPROVEMENT OF THE DEFECT GEOMETRY RESOLUTION OF NDT SYSTEMS. 4. DEVELOPMENT OF FRACTURE MECHANICS THEORY TO MORE EFFECTIVELY PROVIDE FOR PLASTICITY AND BOUNDARY EFFECTS. COMPOSITE PRESSURE VESSEL TECHNOLOGY PROGRAMS WILL INCLUDE: 1. EVALUATION OF GLASS FIBER AND RECENTLY DEVELOPED HIGH-MODULUS FIBERS OF GRAPHITE AND BORON. 2. DEVELOPMENT OF METALLIC LINERS, BOTH LOAD BEARING AND THIN WALL, AND OPTIMIZATION OF WINDING PATTERNS AND WINDING VARIABLES FOR CONTROL OF LOCAL STRAIN MISMATCH BETWEEN LINERS AND OVERWRAP. 3. DEMONSTRATION TESTING OF COMPOSITE VESSELS TO ESTABLISH TECHNOLOGY AVAILABILITY.

RTOP NO. 124-08-12 TITLE: NASTRAN (NASA STRUCTURAL ANALYSIS) PROGRAM  
ORGANIZATION: GODDARD SPACE FLIGHT CTR.  
MONITOR: FORLIFER, W. R. TEL. 301-982-4245  
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS EFFORT IS TO DEVELOP FOR NASA A HIGHLY EFFICIENT GENERAL PURPOSE COMPUTER PROGRAM FOR STRUCTURAL ANALYSIS. THERE ARE, AT PRESENT, A GREAT NUMBER OF SPECIAL PURPOSE COMPUTER PROGRAMS FOR SOLVING VARIOUS PARTS OF THE TOTAL STRUCTURAL ANALYSIS PROBLEM. THE USE OF THESE PROGRAMS FOR LARGE PROBLEMS IS GENERALLY HIGHLY INEFFICIENT AND WHEN DIFFERENT PROGRAMS ARE USED IN THE ANALYSIS OF DIFFERENT PARTS OF THE TOTAL SPACE VEHICLE, THE RESULTS ARE DIFFICULT TO COMMUNICATE AND INTEGRATE BY NASA CENTERS AND THEIR CONTRACTORS. NASTRAN WILL PROVIDE A STANDARD GENERAL PURPOSE PROGRAM WHICH CAN BE EFFICIENTLY USED ON LARGE PROBLEMS, INCLUDING THE TOTAL SPACE VEHICLE. THE FINITE ELEMENT APPROACH IS USED AND SOLUTIONS CAN BE OBTAINED BY EITHER THE FORCE OR DISPLACEMENT METHOD. THE PROGRAM IS MODULAR TO ALLOW FOR EASE OF REVISIONS AND IMPROVEMENTS. IN SUPPORT OF THIS PROGRAM, GODDARD HAS RESEARCH TASKS IN THE AREAS OF FINITE ELEMENT COMPARISONS, RANDOM

**FREQUENCY DISTRIBUTION, MATRIX CONDITIONING, AND DESIGN OPTIMIZATION.**

**RTOP NO. 124-08-13 TITLE: LOW-FREQUENCY STRUCTURAL DYNAMICS**

**ORGANIZATION: LANGLEY RESEARCH CENTER**

**MONITOR: BROOKS, G. W. TEL. 703-827-3285**

**TECHNICAL SUMMARY**

THE OBJECTIVE OF THIS RESEARCH IS TO EXPAND THE UNDERSTANDING OF THE LOW FREQUENCY DYNAMIC LOADS ON SPACE VEHICLE STRUCTURES, THE DYNAMIC CHARACTERISTICS OF THE STRUCTURES, AND THE RESPONSE OF STRUCTURES TO LOADS. BOTH ANALYTICAL AND EXPERIMENTAL APPROACHES WILL BE UTILIZED TO DETERMINE INPUTS, STRUCTURAL SYSTEM TRANSFER FUNCTIONS, AND RESPONSES OF LAUNCH VEHICLE, SPACE SHUTTLE, SPACECRAFT, ORBITAL BASE, AND ENTRY VEHICLE CONFIGURATIONS. WIND TUNNELS AND DYNAMIC MODELS WILL BE USED EXTENSIVELY FOR THIS ONGOING IN-HOUSE RESEARCH AND WILL BE SUPPLEMENTED BY CONTRACT RESEARCH. THE RESULTS WILL LEAD TO LIGHTER WEIGHT AND MORE RELIABILITY IN CURRENT VEHICLES AND ESTABLISH THE FEASIBILITY AND CONFIGURATIONS OF FUTURE CONCEPTS.

**RTOP NO. 124-08-14 TITLE: HIGH FREQUENCY DYNAMICS (AERODYNAMIC NOISE)**

**ORGANIZATION: LANGLEY RESEARCH CENTER**

**MONITOR: BROOKS, G. W. TEL. 703-827-3285**

**TECHNICAL SUMMARY**

THIS RESEARCH WILL PROVIDE IMPROVEMENTS IN THE STATE OF THE ART FOR DESIGNING SPACE VEHICLES TO SUSTAIN HIGH FREQUENCY DYNAMIC LOADS. THESE DYNAMIC LOADS MAY BE SINUSOIDAL, RANDOM, OR TRANSIENT IN NATURE, SUCH AS ACOUSTIC PRESSURES OR PYROTECHNIC SHOCKS, AND OFTEN LEAD TO LOCAL STRUCTURAL FAILURES OR EQUIPMENT MALFUNCTIONS. IMPROVED DEFINITION OF THESE LOADS IS REQUIRED TO DEVELOP MORE ADEQUATE SIMULATION TECHNIQUES, PREPARE MORE REALISTIC TEST SPECIFICATIONS, AND DEVELOP BETTER PROTECTIVE DEVICES FOR SENSITIVE COMPONENTS. ANALYTICAL METHODS MUST ALSO BE DEVELOPED TO PREDICT RESPONSE TO THE LOADS. THE RESEARCH PROGRAM WILL UTILIZE EXISTING FLIGHT DATA, GROUND TESTS, AND FLIGHT TESTS AS WELL AS ANALYSIS AND WILL BE CONDUCTED IN-HOUSE BUT SUPPLEMENTED BY UNIVERSITY GRANTS AND INDUSTRY CONTRACTS. ANY SIGNIFICANT IMPROVEMENTS IN THIS TECHNOLOGY WILL BE IMMEDIATELY APPLICABLE TO ALL FUTURE SPACECRAFT AND CAN LEAD TO REDUCED COST AND IMPROVED RELIABILITY.

**RTOP NO. 124-08-14 TITLE: HIGH FREQUENCY LAUNCH DYNAMICS (AERODYNAMIC NOISE)**

**ORGANIZATION: MARSHALL SPACE FLIGHT CENTER**

**MONITOR: BROOKS, G. W. TEL. 205-453-1120**

**TECHNICAL SUMMARY**

THE BASIC OBJECTIVE OF THIS PLAN IS THE IMPROVEMENT OF TECHNIQUES AND METHODS FOR THE PREDICTION AND SIMULATION OF ENGINE INDUCED HIGH FREQUENCY LAUNCH ACOUSTIC AND FLIGHT MECHANICAL DYNAMIC

FORCING FUNCTIONS AND RESULTANT RESPONSE. THE ACOUSTIC ENVIRONMENT MUST BE DEFINED IN DETAIL WITH THE AMPLITUDE AND PHASE INFORMATION PHYSICALLY RELATABLE TO THE CONTRIBUTING VARIABLES ASSOCIATED WITH ROCKET OR JET FLOW FIELDS OR THE INFLIGHT FLOW FIELD OVER THE VEHICLE. THE CORRELATION CHARACTERISTICS AND THE PRESSURE FIELD MUST BE KNOWN TO APPLY RESPONSE PREDICTIONS WITH ANY REASONABLE ACCURACY. SUCH INFORMATION IS NECESSARY FOR THE IDENTIFICATION OF LIMITATIONS AND OVER CONSERVATISMS INHERENT IN CURRENT DESIGN PROCEDURES. ELIMINATION OF THIS OVER DESIGN AND POTENTIAL UNDERDESIGN IN VARIOUS SYSTEMS AND STRUCTURAL COMPONENTS WILL BE BASED ON IMPROVED METHODS AND NEW APPROACHES MADE POSSIBLE BY AN ACCURATE ESTIMATION OF THE CONTROLLING INPUT ENVIRONMENTS. HIGH FREQUENCY DYNAMIC MODELING TECHNIQUES WILL BE IMPROVED ALONG WITH CHARACTERISTICS AND CUMULATIVE FATIGUE DAMAGE. SOLUTIONS TO THESE PROBLEMS WILL BE INVESTIGATED UTILIZING NEW CONCEPTS SUCH AS POWER FLOW FORCE SPECTRUM TECHNIQUES, AND, WHERE EXACT SOLUTIONS ARE IMPOSSIBLE, TO FULLY UTILIZE STATISTICAL TECHNIQUES.

RTOP NO. 124-08-14 TITLE: HIGH FREQUENCY LAUNCH DYNAMICS  
(AERODYNAMIC NOISE)

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP METHODS OF PREDICTING HIGH FREQUENCY DYNAMIC LOADS DURING LAUNCH, THE RESPONSE OF THE STRUCTURE AND SPACECRAFT COMPONENTS TO THESE LOADS AND METHODS FOR SIMULATING THE LOADS AND STRUCTURES IN TESTS. SPECIFICALLY THE WORK WILL BE DIRECTED TOWARD AERODYNAMIC NOISE, THE STRUCTURAL RESPONSE TO SUCH LOADS, AND THERMALLY INDUCED OSCILLATIONS. IMPROVEMENT IN THE STATE-OF-THE-ART FOR PREDICTING THE HIGH-FREQUENCY DYNAMIC LOADS AND RESPONSES IS VITAL TO THE REDUCTION OF THE HIGH COSTS NOW NECESSARY FOR THE FULL SCALE PROOF TESTING OF FLIGHT HARDWARE. THE WORK PERFORMED UNDER THIS RTOP IS EXPECTED TO FORM THE BASIS FOR DEVELOPMENT OF METHODS FOR PREDICTING THE RESPONSE OF FULL SCALE STRUCTURES TO LAUNCH DYNAMIC LOADS AND/OR FOR RELIABLY EXTRAPOLATING THE RESULTS OF LABORATORY TESTS TO FLIGHT SCALE.

RTOP NO. 124-08-14 TITLE: HIGH FREQUENCY LAUNCH DYNAMICS (TEST  
SIMULATION)

ORGANIZATION: GODDARD SPACE FLIGHT CTR.

MONITOR: FORLIFER, W. R. TEL. 301-982-4245

TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS EFFORT IS TO PROVIDE A MUCH NEEDED IMPROVEMENT IN THE STATE-OF-THE-ART FOR THE PREDICTION AND TEST SIMULATION OF THE LAUNCH DYNAMIC ENVIRONMENTS (VIBRATION, SHOCK, AND ACOUSTIC NOISE). THE PROBLEM IS TO DEVELOP PREDICTION TECHNIQUES, TEST METHODS, AND TEST PHILOSOPHY WHICH WILL PROVIDE HIGHER FLIGHT RELIABILITY OF SPACECRAFT AND SPACE VEHICLE EQUIPMENT WITHOUT CAUSING UNNECESSARY DESIGN PENALTIES IN COST AND WEIGHT. GODDARD HAS BEEN DESIGNATED AS THE LEAD CENTER IN THE AREA OF TEST SIMULATION AND

RANDOM ANALYSIS APPLICATION BY OART. THIS RESPONSIBILITY INCLUDES THE ASSESSMENT OF THE STATE-OF-THE-ART IN THIS AREA AND THE ESTABLISHMENT OF A PLAN FOR THE NASA RESEARCH PROGRAM THAT IS REQUIRED. IN SUPPORT OF THIS PROGRAM, GODDARD HAS BOTH ON-GOING AND PLANNED RESEARCH EFFORTS IN THE AREAS OF COMBINED ENVIRONMENT TESTING, ACOUSTIC NOISE TESTING, APPLICATION OF MECHANICAL IMPEDANCE TECHNIQUES, PREDICTION OF INTERFACE DAMPING, MECHANICAL TEST METHODS, DIGITAL DATA ANALYSIS, COMPILATION OF PYROTECHNIC SHOCK DATA, ADVANCED SHAKER APPLICATIONS, SYSTEM IDENTIFICATION, AND TEST SPECIFICATION DEVELOPMENT

RTOP NO. 124-08-15 TITLE: STRUCTURAL MECHANICS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

TO DEVELOP BETTER UNDERSTANDING OF FAILURE OF SPACE VEHICLE STRUCTURES THROUGH BASIC ANALYTICAL AND EXPERIMENTAL STUDIES OF COMPONENT STRUCTURES SUBJECTED TO VARIOUS ASPECTS OF THE FLIGHT ENVIRONMENT. TO IMPROVE PROCEDURES FOR DESIGN OF LIGHTER, MORE RELIABLE SPACE VEHICLE STRUCTURES AND REDUCE THE NUMBER OF EXPENSIVE TEST PROGRAMS REQUIRED TO QUALIFY FLIGHT STRUCTURES THROUGH GENERATION OF MORE ACCURATE, THOROUGH AND COMPREHENSIVE ANALYTICAL METHODS.

RTOP NO. 124-08-16 TITLE: CRYOGENIC STORAGE  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: BROOKS, G. W. TEL. 205-453-1120  
TECHNICAL SUMMARY

ANALYTICAL AND EXPERIMENTAL RESEARCH IS BEING CONDUCTED TO DEVELOP AND ESTABLISH DESIGN CRITERIA, MATERIALS, MANUFACTURING AND INSPECTION TECHNIQUES, OPERATIONAL CONSTRAINTS, INSTRUMENTATION CAPABILITY AND TESTING METHODS FOR EFFICIENT LONG TERM SPACE STORAGE (30 - 300 DAYS) OF CRYOGENS FOR LARGE (UP TO 33' DIA.) PROPULSION STAGES AND LIFE SUPPORT SYSTEMS ON FUTURE MANNED AND UNMANNED SPACE VEHICLES. ANALYTICAL INVESTIGATION OF VARIOUS VEHICLES/MISSIONS WILL BE COMPLEMENTED BY EXPERIMENTAL DATA. HPI DESIGNS WILL BE FORMULATED. LARGE SIZE TANK TYPE CALORIMETERS WILL BE DESIGNED AND FABRICATED. A 105" DIA. TANK WITH A LOW CONDUCTIVITY FIBERGLASS HONEYCOMB CONICAL SUPPORT IS BEING MANUFACTURED. MATERIALS AND DESIGN CONCEPTS ARE BEING EVALUATED BY APPLICATION OF THICK INSULATION BLANKETS TO MOCKUPS AND TO LARGE SCALE TEST TANKS FOR THERMAL AND STRUCTURAL TESTS. NEW TECHNIQUES FOR LEAK TESTING OF CRYOGENIC TANKS WILL BE EVALUATED. TEST FACILITIES WILL BE DEVELOPED THAT WILL PERMIT CRYOGENIC HPI THERMAL TESTING AT SIMULATED DEEP SPACE ENVIRONMENTS. THICK INSULATION BLANKETS WILL BE APPLIED TO THE TEST TANKS TO MINIMIZE SCALING ERRORS. THE ANALYTICAL INVESTIGATION OF DIFFERENT VEHICLE MISSIONS/DESIGNS AND APPLICATION OF THICK HPI ASSEMBLIES TO LARGE CALORIMETER (105 INCH DIA.) WILL PERMIT ACCURATE EXTRAPOLATION OF THE TEST DATA DUE TO MEASURING INACCURACIES AND EXTRANEOUS HEAT SOURCES IN COMPARISON TO SIDEWALL HEAT LEAKS.

COUPLED TO THE HPI PROGRAM WILL BE THE DEVELOPMENT, FABRICATION, AND THERMAL TESTING OF INFLATABLE SOLAR SHIELDS.

RTOP NO. 124-08-16 TITLE: CRYOGENIC PROPELLANT STORAGE AND HANDLING  
ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: SMITH, G. T. TEL. 216-433-4000

TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THE PROGRAMS CONDUCTED UNDER THIS RTOP IS TO PROVIDE THE TECHNOLOGY REQUIRED FOR EFFECTIVE DESIGN AND FABRICATION OF PROPELLANT MANAGEMENT AND THERMAL CONTROL SYSTEMS FOR LONG TERM SPACE STORAGE OF CRYOGENIC AND SPACE STORABLE PROPELLANTS. DESIGN DATA, DESIGN METHODS, AND EVALUATION OF APPROPRIATE PROTOTYPE SYSTEMS WILL BE OBTAINED ON EACH OF THE MAJOR SUBSYSTEMS OF THE PROPELLANT TANK; E.G., THERMAL AND PRESSURE CONTROL SYSTEMS, METEOROID PROTECTION SYSTEMS, AND PROPELLANT CONTROL SYSTEMS. SUCH EVALUATION PROGRAMS WILL BE CONDUCTED ON SHADOW SHIELD SYSTEMS, MULTILAYER INSULATION SYSTEMS, LOW HEAT LEAK SUPPORT SYSTEMS, LOW HEAT LEAK PLUMBING LINES, PROPELLANT MANAGEMENT SYSTEMS, PROPELLANT DESTRATIFICATION SYSTEMS, AND ACTIVE PROPELLANT VENTING SYSTEMS.

RTOP NO. 124-08-18 TITLE: SPACE STATION STRUCTURES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE RESEARCH CONDUCTED UNDER THIS RTOP WILL BE DIRECTED TOWARD THE STUDY OF METHODS TO PROVIDE AND MAINTAIN LARGE ENCLOSED VOLUMES FOR MANNED SPACE STATIONS. EXPANDABLE STRUCTURES USED IN SUPPORT OF SPACE STATION ACTIVITIES SUCH AS EXPANDABLE AIRLOCKS, LIVING QUARTERS, AND SPACE HANGARS WILL BE STUDIED. THE STRUCTURAL AND MECHANICAL PROBLEMS ASSOCIATED WITH THE CREATION OF AN ARTIFICIAL GRAVITY FIELD WILL BE STUDIED. SPECIAL ATTENTION WILL BE FOCUSED ON THE PROBLEMS OF LARGE ROTATING SEALS SUCH AS ARE REQUIRED FOR THE MAN-ROTATING DOCKING HUB OF A ROTATING ARTIFICIAL GRAVITY SPACE STATION AND ON AN EXPANDABLE CYLINDRICAL STRUCTURE DEPLOYED TO OBTAIN A LARGE LENGTH DIMENSION FROM THE MASS CENTER. LOCATION AND REPAIR OF DAMAGE CAUSED BY MICROMETEOROID IMPACT OR BY ACCIDENTAL PUNCTURE WILL BE STUDIED.

RTOP NO. 124-08-19 TITLE: STRUCTURES FOR ORBITING RADIO TELESCOPES

ORGANIZATION: GSFC

MONITOR: HIBBARD, W. D. TEL. 301-982-4278

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP STRUCTURE TECHNOLOGY NEEDED FOR AN ORBITING RADIO TELESCOPE THAT OPERATES IN THE FREQUENCY RANGE OF 1-10 MHZ; AN ACCURATE PARABOLOIDAL REFLECTOR APPROXIMATELY ONE KILOMETER IN DIAMETER IS REQUIRED, PLUS SUPPORTING STRUCTURE FOR THE RF FEED AND ELECTRONICS. A CENTRIFUGALLY DEPLOYED FILAMENTARY NET WITH FORE AND AFT STAYS IS THE MOST PROMISING APPROACH. A FIVE METER DIAMETER

MODEL HAS BEEN DEVELOPED AND SUCCESSFULLY TESTED IN AMBIENT ENVIRONMENT. ADDITIONAL TESTING, INCLUDING AN AEROBEE FLIGHT, IS PLANNED. PRELIMINARY STUDIES OF A 50 METER MODEL ARE UNDER WAY, AND A CONTINUING EFFORT IS DEVOTED TO DEFINING AND ANALYZING THE ULTIMATE TELESCOPE REQUIREMENTS.

RTOP NO. 124-08-20 TITLE: PLANETARY ENTRY AND LANDING STRUCTURES  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP AND VALIDATE THE STRUCTURAL TECHNOLOGY FOR EFFICIENT DESIGN OF BOTH LIGHT WEIGHT ENTRY CAPSULES AND PLANETARY LANDING GEAR SYSTEMS. THE OBJECTIVES WILL BE ACHIEVED THROUGH NUMERICAL METHOD DEVELOPMENT, COMPREHENSIVE ANALYTICAL DESIGN STUDIES, AND FABRICATION AND TEST OF PRACTICAL AEROSHELL CONFIGURATION AND LANDING IMPACT ATTENUATION SYSTEMS.

RTOP NO. 124-08-21 TITLE: LUNAR SHELTER TECHNOLOGY AND ADVANCED DEVELOPMENT  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

IN ORDER TO FACILITATE RESEARCH ON THE LUNAR SURFACE, RESEARCH AND TECHNOLOGY IS DIRECTED TOWARD STRUCTURES FOR CREW LIVING QUARTERS, WORKSHOP SPACE, AND A SURVIVAL SHELTER. STUDIES OF LUNAR SHELTER CONFIGURATIONS AND CANDIDATE LIFE SUPPORT SYSTEMS, MATERIAL EVALUATION AND ASSEMBLY TECHNIQUES FOR STRUCTURAL ELEMENTS, STRUCTURAL DESIGN, SUBSYSTEM DESIGN AND INTEGRATION, THERMAL BALANCE, PACKAGING AND DEPLOYMENT ARE INCLUDED. THIS RESEARCH AND DEVELOPMENT EFFORT IS INTENDED TO PROVIDE THE TECHNOLOGY TO INSURE THE CAPABILITY OF BUILDING A FULL-SCALE PROTOTYPE TO EVALUATE STRUCTURES, SYSTEMS, AND CREW/SHELTER INTERFACES AS A FORERUNNER TO A LUNAR SURFACE QUALIFIED SHELTER.

RTOP NO. 124-08-22 TITLE: VEHICLE CONCEPTS FOR PLANETARY MOBILITY  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: MCDONALD, R. R. TEL. 213-354-6186  
TECHNICAL SUMMARY

ACCEPTUAL AND DETAILED ASPECTS OF MOBILITY SYSTEMS WILL BE EXAMINED. INTERFACES RELATED TO STRUCTURES AND DYNAMICS, THERMAL CONTROL, POWER, COMMUNICATION, GUIDANCE, NAVIGATION, CONTROL AND SCIENCE PAYLOAD WILL BE CONSIDERED SO THAT A DEFINITION OF RESEARCH AND ADVANCED DEVELOPMENT IN STRUCTURES, DYNAMICS, SOIL MECHANICS AND LOCOMOTION CAN BE ARRIVED AT. THE WORK WILL BE ACCOMPLISHED BY A COMBINATION OF INTERFACING WITH NASA CENTERS, OTHER GOVERNMENT AGENCIES, AND INDUSTRY, AND PERFORMING IN-HOUSE STUDIES AND RESEARCH. THE WORK IS REQUIRED SO THAT APPROPRIATE RESEARCH CAN BE PERFORMED AND COMPLETED BEFORE THE MID-1970'S, WHEN IT WILL BE NECESSARY TO

BEGIN DESIGN STUDIES FOR PLANET SURFACE EXPLORATION MISSIONS EXPECTED LATE IN THE 1970'S.

RTOP NO. 124-08-24 TITLE: ENTRY AND LANDING STRUCTURES FOR MANNED  
EARTH ORBITAL SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE STRUCTURES TECHNOLOGY FOR LANDING SYSTEMS OF REUSEABLE ENTRY AND LANDING VEHICLES THAT CAN RETURN TO EARTH FROM SPACE OR THE UPPER ATMOSPHERE. NEW STRUCTURAL CONCEPTS FOR DEPLOYABLE TERMINAL DESCENT DECELERATORS WILL BE DEVELOPED AND RATIONAL METHODS FOR ANALYZING LOADS, STRESSES AND CONFIGURATIONS FOR SUCH DEVICES AS ROTORS, PARACHUTES, AND FLEXIBLE WINGS WILL BE DEVELOPED BY CONTRACTS, GRANT, AND IN HOUSE EFFORTS. LANDING GEAR CONCEPTS WILL BE INVESTIGATED EXPERIMENTALLY FOR REPRESENTATIVE LIFTING BODY CONFIGURATIONS USING SMALL DYNAMIC MODELS TO OBTAIN BEHAVIOR, ACCELERATIONS, STABILITY AND OTHER PERTINENT CHARACTERISTICS. ANALYSES OF THE STRUCTURAL CHARACTERISTICS OF SUCH GEARS WILL BE DEVELOPED BY CONTRACT. INFORMATION NEEDED TO DESIGN STEERABLE LANDING GEAR SYSTEMS WILL BE DEVELOPED BY IN HOUSE ANALYSIS AND EXPERIMENTS. THE RESULTS SHOULD LEAD TO DESIGN TECHNOLOGY THAT CAN BE APPLIED TO A VARIETY OF REUSEABLE LAUNCH VEHICLES AND LOGISTIC SPACECRAFT.

RTOP NO. 124-08-25 TITLE: BOOM STRUCTURES AND DYNAMICS IN ORBITAL  
ENVIRONMENT

ORGANIZATION: GSFC

MONITOR: MARTIN, F. T. TEL. 301-982-5913

TECHNICAL SUMMARY

A TWO PRONGED EFFORT, THEORETICAL ANALYSIS AND DESIGN FEASIBILITY IS DIRECTED TOWARDS SOLVING PRESENT AND FUTURE STRUCTURAL AND ATTITUDE DYNAMICS PROBLEMS ASSOCIATED WITH LARGE FLEXIBLE SPACECRAFT STRUCTURES IN AN ORBITAL ENVIRONMENT. ANALYSIS WILL BE DIRECTED TOWARDS DEVELOPING FUNDAMENTAL KNOWLEDGE AND GENERAL PRINCIPLES FOR THE UNDERSTANDING OF FLEXIBLE BODY DYNAMICS. IN ADDITION, GENERAL COMPUTER PROGRAM TO SIMULATE LARGE NON-LINEAR IN-ORBIT SPACECRAFT DYNAMICS STRUCTURAL BEHAVIOR WILL BE DEVELOPED AND ENLARGED UPON. DESIGN FEASIBILITY STUDIES AND DEVELOPMENT OF A FAMILY OF EXTENDING BOOM AND STRUCTURAL SYSTEMS TO MEET FUTURE EXPERIMENT AND SPACECRAFT MISSION REQUIREMENTS WILL BE UNDERTAKEN.

RTOP NO. 124-08-26 TITLE: SPACECRAFT COMMUNICATIONS ANTENNA  
STRUCTURES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

OTHER PLANET AND PLANETARY ORBIT MISSIONS IN THE 1975-1985



PERIOD WILL REQUIRE INCREASED COMMUNICATION CAPABILITIES. JPL STUDIES INDICATE THAT OPTIMUM TELECOMMUNICATIONS SUBSYSTEM DESIGN FOR THESE MISSIONS IS REALIZED WITH ANTENNAS HAVING MUCH GREATER GAIN THAN THOSE NOW ON MARINER SPACECRAFT; HOWEVER, THE ASSUMED GAIN VS. WEIGHT USED IN THESE STUDIES HAS NOT BEEN VERIFIED, NOR HAS THE TECHNOLOGY FOR THESE LARGER ANTENNAS SUFFICIENTLY WELL DEVELOPED. THE PRINCIPLE OBJECTIVE OF THIS THREE YEAR TASK IS TO FULFILL THE NEED TO DEVELOPE MAKE AVAILIELE THE KNOWLEDGE REQUIRED BY FLIGHT PROJECT TO BE ABLE TO UTILIZE NEW LARGE ANTENNAS. A NUMBER OF ANTENNA CONFIGURATIONS WILL BE CONSIDERED, INCLUDING PARABOLOIDAL ANTENNAS FROM 15 TO 100 FEET IN DIAMETER, WHICH WILL NECESSARILY BE UNFURLABLE. THE SELECTED APPROACH IS TO FIRST INVESTIGATE UNFURLABLE HIGH GAIN ANTENNA CONCEPTS APPLICABLE TO THE RANGE OF SIZES AND OPERATING FREQUENCIES OF INTEREST, AND TO DEVELOPE THE ANALYTIC PROBABILITIES AND MATERIALS EXPERTISE NECESSARY TO SUPPORT THESE INVESTIGATIONS. CRITERIA WHICH WILL BE CONSIDERED WILL INCLUDE: WEIGHT (GOAL IS 0.25 LB/FT OR BETTER), SURFACE ACCURACY IN THE OPERATING ENVIRONMENT, RELIABILITY OF DEPLOYMENT, LONG LIFE, NATURAL FREQUENCY INTERACTION WITH THE ATTITUDE CONTROL SUBSYSTEM, AND AMENABILITY TO PRE-FLIGHT VERIFICATION BY ANALYSIS AND TEST. FOLLOWING THIS FIRST PHASE A SPECIFIC ANTENNA BEST TYPIFYING ANTICIPATED REQUIREMENTS WILL BE DESIGNED AND APPROPRIATE HARDWARE WILL BE FABRICATED AND TESTED. THE EFFORT ON THIS MECHANICAL TASK WILL BE COORDINATED WITH "MICROWAVE DEEP SPACE COMMUNICATIONS AND TRACKING", RTOP CODE 125-21-09. IT SHOULD BE NOTICED THAT A 14 FT.-DIAMETER UNFURLABLE X-BRAND ANTENNA IS BEING DEVELOPED FOR THIS. THIS TASK DOES NOT DUPLICATE, BUT RATHER, COMPLIMENTS WORK BEING DONE THEREIN. ANOTHER OBJECTIVE OF THIS TASK IS TO----

RTOP NO. 124-08-28 TITLE: ADVANCED STRUCTURAL CONCEPT STUDIES

ORGANIZATION: NASA HEADQUARTERS

MONITOR: ROSCHE, M. G. TEL. 000-962-0151

#### TECHNICAL SUMMARY

THE OBJECTIVES ARE TO PROVIDE ASSESSMENTS AND SUMMARIES OF THE STATE-OF-THE-ART IN STRUCTURES/MATERIALS TECHNOLOGY, MAKE CRITICAL EXAMINATIONS IN CRUCIAL AREAS TO GUIDE FUTURE RESEARCH, CONDUCT INITIAL EXPLORATORY RESEARCH TO DEFINE FUTURE FRUITFUL DIRECTION, AND INITIATE NEW EFFORT AS A NUCLEUS FOR LATER CENTER PROGRAMS. SPECIFIC OBJECTIVES INCLUDE EXPLOITATION OF OPTIMAL STRUCTURAL CONFIGURATIONS IN TERMS OF PROTOTYPE MODELS TO DEMONSTRATE FEASIBILITY OF CONCEPT, PRELIMINARY IDENTIFICATION OF PROCESSES APPLICABLE TO DEVELOPMENT OF COMPOSITE MATERIALS WHICH HAVE DESIGNED THERMAL AND STRUCTURAL CHARACTERISTICS, STUDIES OF PARAMETERS AFFECTING LOGISTIC SPACECRAFT STRUCTURAL COST-EFFECTIVENESS, AND A STUDY OF KEY STRUCTURAL/MATERIAL ELEMENTS IN AN ADVANCED SPACECRAFT CONCEPT OF EXTREMELY LARGE SURFACE AREA.

RTOP NO. 124-08-29 TITLE: DYNAMIC INTERACTIONS OF GASES, FLUIDS,  
PARTICLES AND STRUCTURES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE IS TO INVESTIGATE PHENOMENA PECULIAR TO SPACE MISSIONS WHICH INVOLVE THE DYNAMIC BEHAVIOR OF FLUIDS CONTAINED IN STRUCTURES DURING VARIOUS PHASES OF SPACE FLIGHT, OF ROCKET EXHAUST FLOWS INTERACTING WITH SURFACES, AND OF LUNAR OR PLANETARY PARTICULATE SURFACES SUBJECTED TO SPACECRAFT LANDINGS, TO SITE SAMPLING OR TO SITE DEVELOPMENT. THE APPROACH BEING TAKEN INVOLVES CARRYING OUT EXPERIMENTAL AND ANALYTICAL STUDIES TO DETERMINE THE DYNAMIC BEHAVIOR OF GASES, FLUIDS AND PARTICLES ALONE, IN COMBINATION, AND WITH INTERACTING STRUCTURES. AREAS INVESTIGATED WILL INCLUDE NEAR AND FAR-FIELD JET EXHAUST BEHAVIOR, DYNAMIC BEHAVIOR OF LIQUIDS AND CONTAINING STRUCTURES INCLUDING ANTI-SLOSH AND EXPULSION DEVICES; PHYSICAL PROPERTIES OF VARIOUS CANDIDATE PARTICULATE SURFACES FOR THE MOON AND PLANETS; AND BEHAVIOR OF SUCH SURFACES WHEN DISTURBED, SUCH AS BY IMPACTING BODIES, JETS, OR EXPLOSIVES. EFFECTS OF EXTRATERRESTRIAL ENVIRONMENTAL FACTORS (REDUCED GRAVITY, REDUCED AMBIENT PRESSURES, ETC.) ON DYNAMIC BEHAVIOR WILL BE CONSIDERED. LIKELY APPLICATIONS IN SPACE MISSIONS INCLUDE THE CONFIGURING OF: LIQUID TANKAGE FOR LAUNCH VEHICLES; EXHAUST JETS AND JET OPERATION REQUIRED NEAR STRUCTURAL OR EXTRATERRESTRIAL SURFACES TO MINIMIZE RISK OF VEHICLE DAMAGE OR INTERFERENCE WITH SCIENTIFIC MEASUREMENTS; AND STRUCTURES, VEHICLES, AND SITE DEVELOPMENT TECHNIQUES INVOLVED IN LUNAR OR PLANETARY LANDINGS, BASE OPERATIONS, OR SURFACE EXPLORATION.

RTOP NO. 124-08-30 TITLE: DEFINITION OF EFFICIENT  
STRUCTURAL/THERMAL SPACE SHUTTLE  
(CATEGORY I) PROTECTION SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE GOAL OF THE OUTLINED PROGRAM IS TO DEFINE EFFICIENT AND ECONOMICAL STRUCTURES AND THERMAL PROTECTION SYSTEMS FOR MANNED SPACE SHUTTLES. THIS WILL BE ACCOMPLISHED BY A PRIMARILY ANALYTICAL IN-HOUSE DESIGN STUDY OF PROPOSED SPACE SHUTTLE CONFIGURATIONS TO DETERMINE THE EFFECT OF MISSION CRITERIA, ENVIRONMENTS, AND OTHER SUBSYSTEMS ON STRUCTURES AND THERMAL PROTECTION REQUIREMENTS. STRUCTURAL AND THERMAL PROTECTION SYSTEMS WHICH MEET THE REQUIREMENTS WILL BE SELECTED AND OPTIMIZED FOR VARIOUS CONFIGURATIONS. CANDIDATE SYSTEMS WILL INCLUDE PROMISING NEW PRIMARY STRUCTURE CONCEPTS WHOSE PERFORMANCE WILL BE EVALUATED WITH SELECTED TESTS. THE APPLICATION OF COMPOSITES TO THE DEVELOPMENT OF LIGHTWEIGHT THRUST STRUCTURES WILL BE INVESTIGATED. INPUT FROM MORE COMPREHENSIVE EXPERIMENTAL PROGRAMS ON PRIMARY STRUCTURE AND THERMAL PROTECTION SYSTEMS AT MSFC AND MSC WILL ALSO BE USED. INITIAL PARAMETRIC STUDIES WILL IDENTIFY, FOR EACH GENERIC VEHICLE TYPE, A MOST PROMISING STRUCTURAL/THERMAL PROTECTION ARRANGEMENT FOR FURTHER, IN-DEPTH STUDY. UNDER THIS RTOP AND FOR COMPREHENSIVE EVALUATION AT MSFC THROUGH THE DESIGN,

FABRICATION AND TEST OF LARGE SCALE STRUCTURAL MODELS. FOR IN-DEPTH STUDY OF THE MOST PROMISING ARRANGEMENTS, TOTAL MANNED SPACE SHUTTLE SYSTEMS WILL BE SYNTHESIZED FOR LEAST WEIGHT TO PERMIT DETERMINATION OF THE INTERACTION BETWEEN STRUCTURES AND THERMAL PROTECTION SYSTEMS AND OTHER SUBSYSTEMS EACH AS PROPULSION, LANDING GEAR, TANKS AND INTER-TANK STRUCTURES, AND CARGO COMPARTMENTS. THE SENSITIVITY OF PAYLOAD TO SELECTED STRUCTURAL APPROACHES WILL BE DETERMINED AND THE RELATIVE DEVELOPMENT AND RECURRING COSTS WILL BE ASSESSED. THE RESULTS OF THIS WORK SHOULD PROVIDE A RATIONAL BASIS FOR SELECTION OF EFFICIENT MANNED SPACE SHUTTLE STRUCTURES AND THERMAL PROTECTION.-----

RTOP NO. 124-08-31 TITLE: MANNED SPACE SHUTTLE (CATEGORY 1):  
DYNAMICS AND AEROELASTICITY

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP THE LOADS, STRUCTURAL DYNAMICS, AND AEROELASTICITY TECHNOLOGY OF SPACE SHUTTLE VEHICLES, SPECIFICALLY, SUCH PROBLEMS AS LUFFET; FLUTTER; GROUND WINDS; FUEL SLOSH; WINDS, GUST AND CONTROL LOADS; POGO; BOUNDARY LAYER NOISE AND SHOCK WILL BE TREATED. PROPOSED CONFIGURATIONS AND OPERATING REQUIREMENTS INTRODUCE THE NEW FACTORS OF ASYMMETRY, PARALLEL-STAGED MULTIBODIES, AND HIGH TEMPERATURES INTO THESE DYNAMICS PROBLEMS. BOTH ANALYTICAL AND EXPERIMENTAL APPROACHES ARE REQUIRED TO DETERMINE CRITICAL LOADING CONDITIONS, VEHICLE CHARACTERISTICS, AND VEHICLE RESPONSES AND STABILITY BOUNDARIES. DYNAMIC MODELS AND WIND TUNNELS WILL BE USED EXTENSIVELY FOR THIS INHOUSE AND CONTRACT EFFORT. THE RESULTS WILL INFLUENCE CONFIGURATION SELECTION AND LEAD TO LIGHTER WEIGHT AND MORE RELIABILITY IN THE FINAL CONFIGURATION.

RTOP NO. 124-08-32 TITLE: DEVELOPMENT OF CRYOGENIC INSULATION  
SYSTEM MATERIALS FOR LIGHTWEIGHT  
COMPOSITE INSULATION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: BROOKS, G. W. TEL. 205-453-1120

TECHNICAL SUMMARY

THE CRYOGENIC FUEL REQUIREMENTS ARE VERY LARGE FOR THE SHUTTLE VEHICLE. THE DECISION IS STILL OPEN WHETHER TO USE INTERNAL OR EXTERNAL INSULATION AND BOTH MUST BE DEVELOPED TO DETERMINE THE OPTIMUM ARRANGEMENT. THERE IS ALSO A REQUIREMENT TO DEVELOP LIGHTWEIGHT COMPOSITES THAT CAN BE USED TO INSULATE TANKS FOR TRANSPORTING CRYOGENS FOR REPLENISHING THE SPACE STATION AND OTHER NEEDS. A REQUIREMENT EXISTS TO DEVELOP IMPROVED PRIMERS FOR USE ON ALUMINUM IN CONJUNCTION WITH SPRAY-FOAM INSULATION SYSTEMS.

RTOP NO. 124-08-33 TITLE: MANNED SPACE SHUTTLE MISSION SIMULATION  
STRUCTURAL TESTS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: BROOKS, G. W. TEL. 205-453-1120

TECHNICAL SUMMARY

REUSABLE INTEGRAL LAUNCH AND RECOVERY VEHICLES WILL BE THE PREDOMINANT SPACE DELIVERY SYSTEM IN THE MID-1970'S. THE REQUIREMENTS FOR DEVELOPMENT OF A VEHICLE ARE LOW OVERALL MISSION COST, FAST, LOW COST MAINTENANCE, HIGH RELIABILITY OF THE STRUCTURE FOR MULTIPLE FLIGHTS, AND LOW DEVELOPMENT RISK. THE ENVISIONED PROPULSION SYSTEM (LOX/LH2) AND NUMBER OF STAGES IS WEIGHT CRITICAL AND ASSURANCES WILL BE NEEDED THAT ESTIMATED WEIGHTS WILL BE MAINTAINED DURING THE VEHICLE DEVELOPMENT. SUBSTANTIAL WEIGHT INCREASES COULD JEOPARDIZE THE SUCCESS OF THE WHOLE SYSTEM. A NUMBER OF DISCIPLINES MUST WORK CLOSELY TOGETHER IN THE SELECTION OF THE THERMAL PROTECTION/PRIMARY STRUCTURE SYSTEM DESIGN. THESE ARE: STRUCTURAL DESIGN, STRUCTURAL ANALYSIS, MATERIALS DEVELOPMENT, THERMODYNAMIC AND AERODYNAMIC ANALYSIS, FABRICATION METHODS AND REFURBISHMENT, QUALITY ASSURANCE AND INSPECTION METHODS, MISSION PLANNING AND FACILITY DESIGN. ALL SPECIFIC RESEARCH REQUIREMENTS ARE COMBINED IN THIS RTOP TO ASSURE ACROSS-THE-BOARD PARTICIPATION IN THE SELECTION OF A REUSABLE, LOW COST THERMAL PROTECTION SYSTEM. REVIEW OF THE CURRENT STATE-OF-THE-ART INDICATES THERMAL PROTECTION SYSTEMS OF REUSABLE VEHICLES THE LEAST DEVELOPED IN THE TOTAL ILRV PROGRAM, THEREFORE TO ASSESS THE DESIGN PROBLEM OF THE THERMAL PROTECTION SYSTEM ADVANCED TECHNOLOGY MUST BE PURSUED.

RTOP NO. 124-08-34 TITLE: SHUTTLE STRUCTURAL MATERIALS REUSE  
EVALUATION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: BROOKS, G. W. TEL. 205-453-1120

TECHNICAL SUMMARY

THE ALL REUSABLE STAGES GROUND RULE FOR THE SPACE SHUTTLE IMPOSES TECHNOLOGICAL REQUIREMENTS ON MATERIALS SIGNIFICANTLY GREATER THAN PREVIOUS SINGLE FLIGHT OPERATIONS. IT BECOMES IMPERATIVE TO ESTABLISH LIFETIMES AND REUSE CAPABILITY OF MATERIALS--INCLUDING REFURBISHMENT OPERATIONS--IN ORDER TO ASSURE THE INTEGRITY OF MATERIALS ON SUCCEEDING FLIGHT. THIS HAS NOT BEEN NECESSARY HERETOFORE. IN ORDER TO ACCOMPLISH ADEQUATE SHUTTLE MATERIALS REUSE EVALUATION, AT LEAST FOUR PHASES OF EFFORT ARE REQUIRED: 1. KNOWLEDGE OF MATERIALS DEGRADATION PHENOMENA--INCLUDING THE EFFECTS OF FLAWS, CRACKS, ETC. 2. CONSIDERATION OF THE EFFECTS OF SUCH DEGRADATION UPON THE STRUCTURAL OR FUNCTIONAL RELIABILITY OF THE SYSTEM OR COMPONENT UTILIZING THE MATERIAL. 3. DEVELOPMENT OR ESTABLISHMENT OF REPAIR METHODS, REPLACEMENT, PROCEDURES, OR OTHER CORRECTIVE MEASURES, INCLUDING PREVENTIVE MAINTENANCE. 4. DEVELOPMENT OF METHODS OF MONITORING THE INTEGRITY OF MATERIALS--BOTH DURING GROUND TURNAROUND OPERATIONS--AND WHERE FEASIBLE, ON BOARD THE SHUTTLE VEHICLE.

RTOP NO. 124-08-35 TITLE: BEARINGS, LUBRICANTS, AND SEALS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: BROOKS, G. W. TEL. 205-453-1120  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PLAN IS TO PROVIDE SOLUTIONS TO THE PROBLEMS OF LUBRICATING BEARING SYSTEMS AND OTHER COMPONENTS FOR LONG LIFETIMES IN THE VARIETY OF ENVIRONMENTS WHICH WILL BE ENCOUNTERED BY SHUTTLE SPACECRAFT. EARLY ORBITAL FLIGHTS OF BOTH SATELLITES AND MANNED SPACECRAFT HAVE HAD LUBRICATIONS SYSTEMS THAT WERE COMPLETELY SEALED OR THAT HAD RELATIVELY SHORT LIFE REQUIREMENTS. EVEN SUCH SPACECRAFT AS THE APOLLO TELESCOPE MOUNT AND THE ORBITAL WORKSHOP HAVE LIMITED LIFE REQUIREMENTS WHICH ARE WITHIN THE PRESENT STATE OF THE ART. IT IS INTENDED TO ACCOMPLISH THE ABOVE OBJECTIVE BY THE CONTINUED DEVELOPMENT OF FLUID AND DRY LUBRICANTS AND BY THE DEVELOPMENT OF SPECIAL DESIGNS FOR SLIDING AND ROLLING ELEMENTS WHICH WILL MEET THE LIFE AND ENVIRONMENTAL REQUIREMENTS POSED BY THESE ADVANCED SYSTEMS.

RTOP NO. 124-08-36 TITLE: HIGH TEMPERATURE INSULATION MATERIALS FOR  
A RERADIATIVE THERMAL PROTECTION SYSTEM  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: BROOKS, G. W. TEL. 205-453-1120  
TECHNICAL SUMMARY

REGARDLESS OF ITS EXACT GEOMETRY, THE SHUTTLE VEHICLE WILL PROBABLY HAVE A REFRACTORY METAL OR SUPER ALLOY RERADIATIVE SKIN OVERCERTAIN AREAS OF THE PRIMARY STRUCTURE. IT IS THE GOAL OF THE PROGRAM TO DEVELOPE INSULATION MATERIALS WHICH WILL BLOCK THE TRANSFER OF HEAT FROM THE BACK SIDE OF THE RERADIATIVE SKIN TO THE PRIMARY STRUCTURE. RIGIDIZED, FIBROUS INSULATIONS AND OTHER LIGHTWEIGHT CERAMIC MATERIALS WILL BE EVALUATED FOR REPETITIVE USE IN ENVIRONMENTS SIMULATING THE SHUTTLE OPERATIONAL CYCLE. A SYSTEM USING THE HEAT ABSORPTION OCCURING DURING PHASE CHANGE FROM SOLID TO LIQUID (HEAT OF FUSION) WILL BE EVALUATED AS A METHOD OF BLOCKING HEAT TRANSFER TO THE STRUCTURE. THIS SYSTEM WOULD BE USED IN CONJUNCTION WITH AN INSULATION MATERIAL AND WOULD REPLACE EITHER A PORTION OF THE INSULATION SYSTEM OR AN ACTIVE COOLING SYSTEM REQUIRED TO MAINTAIN STRUCTURAL TEMPERATURE WITHIN DESIGN LIMITS.

RTOP NO. 124-08-37 TITLE: MANNED SPACE SHUTTLE COMPOSITES FOR  
PRIMARY STRUCTURE  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: BROOKS, G. W. TEL. 205-453-1120  
TECHNICAL SUMMARY

REUSABLE INTEGRAL LAUNCH AND RECOVERY VEHICLES WILL BE THE PREDOMINANT SPACE DELIVERY SYSTEM IN THE MID-1970'S. THE REQUIREMENTS FOR DEVELOPMENT OF A VEHICLE ARE LOW OVERALL MISSION COST, FAST, LOW COST MAINTENANCE, HIGH RELIABILITY OF THE STRUCTURE FOR MULTIPLE FLIGHTS, AND LOW DEVELOPMENT RISK. THE ENVISIONED PROPULSION SYSTEM (LOX/LH2) AND NUMBER OF STAGES IS WEIGHT CRITICAL AND ASSURANCES WILL BE NEEDED THAT ESTIMATED WEIGHTS WILL BE

MAINTAINED DURING THE VEHICLE DEVELOPMENT. SUBSTANTIAL WEIGHT INCREASES COULD JEOPARDIZE THE SUCCESS OF THE WHOLE SYSTEM. A NUMBER OF DISCIPLINES MUST WORK CLOSELY TOGETHER IN THE SELECTION OF THE THRUST STRUCTURE CONCEPT. THESE ARE: STRUCTURAL DESIGN, STRUCTURAL ANALYSIS, MATERIALS DEVELOPMENT, THERMODYNAMIC AND AERODYNAMIC ANALYSIS, FABRICATION METHODS AND REFURBISHMENT, QUALITY ASSURANCE AND INSPECTION METHODS, MISSION PLANNING AND FACILITY DESIGN. ALL SPECIFIC RESEARCH REQUIREMENTS ARE COMBINED IN THIS RTOP TO ASSURE ACROSS-THE-BOARD PARTICIPATION IN THE SELECTION OF A REUSABLE, MINIMUM WEIGHT STRUCTURALLY EFFICIENT, FABRICABLE, INSPECTABLE THRUST STRUCTURE.

RTOP NO. 124-08-38 TITLE: SHUTTLE STRUCTURAL MATERIALS DESIGN  
SUPPORT DATA

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: BROOKS, G. W. TEL. 205-453-1120

TECHNICAL SUMMARY

SELECTION, DEVELOPMENT, AND DETERMINATION (AND/OR METHODS) WHERE NECESSARY--OF RELIABLE BASE LINE MATERIALS PROPERTY DATA NECESSARY FOR DESIGN OF THE SPACE SHUTTLE.

RTOP NO. 124-08-39 TITLE: MANNED SPACE SHUTTLE: DYNAMIC LOADS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-1111

TECHNICAL SUMMARY

WIND TUNNEL TESTS AND ANALYSIS WILL BE CONDUCTED TO INVESTIGATE SEVERAL DYNAMIC AND AEROELASTIC PROBLEMS THAT MUST BE CONFRONTED IN THE EVALUATION OF CONFIGURATIONS AND THE DEVELOPMENT OF A SPACE SHUTTLE VEHICLE. THE PRIMARY EMPHASIS WILL BE ON TRANSONIC BUFFET (INCLUDING AEROELASTIC EFFECTS), AERODYNAMIC NOISE INPUTS AND RESPONSE, AND PANEL FLUTTER. MOST OF THE WORK WILL BE EXPERIMENTAL. SUCH TESTS ARE NECESSARY SINCE PROPOSED CONFIGURATIONS OF SHUTTLE VEHICLES WILL BE EXPOSED TO STRONG INTERFERENCE FLOWS, OSCILLATING SHOCKS, LARGE AREAS OF SEPARATED FLOW, AND TO POSSIBLE MOTION COUPLED SEPARATION AND ATTACHMENT OF FLOW. THE CONSIDERATION OF FIXED-WING CONFIGURATIONS ALSO INTRODUCES THE POSSIBILITY OF WING BUFFET AT ZERO OR LOW LIFT THROUGHOUT THE TRANSONIC SPEED RANGE. THE WORK PERFORMED WILL SUPPORT THE EVALUATION OF CANDIDATE SPACE SHUTTLE CONFIGURATIONS FROM A DYNAMIC LOADS POINT OF VIEW, AND WILL PROVIDE UNSTEADY LOADS INFORMATION NEEDED FOR THE DESIGN OF RELIABLE MINIMUM-WEIGHT STRUCTURES.

RTOP NO. 124-08-40 TITLE: COMPOSITE TANKAGE TECHNOLOGY

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: NORED, D. L. TEL. 216-433-400

TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS RTOP WILL BE DIRECTED TO PROVIDING THE SPECIFIC TECHNOLOGY REQUIREMENT ARISING FROM THE APPLICATION OF



FILAMENT-WOUND STRUCTURES TO SHUTTLE VEHICLE DEVELOPMENT PROGRAMS. APPLICATIONS FOR THIS TECHNOLOGY MAY INCLUDE LARGE LOW-PRESSURE, LOAD-CARRYING PRIMARY STRUCTURE LIQUID PROPELLANT TANKS, NON INTEGRAL (NON-LOAD CARRYING) LIQUID TANKS, AND SMALL HIGH-PRESSURE GAS AND SUPER-CRITICAL CRYOGENIC FLUID STORAGE. FILAMENTS OF GLASS FIBERS AND GRAPHITE FIBERS CAN OFFER SIGNIFICANT WEIGHT OR COST SAVINGS WHILE MAINTAINING OR IMPROVING THE RELIABILITY ATTAINABLE WITH CONVENTIONAL METAL VESSELS. THE ACCELERATED DEVELOPMENT OF THE ADVANCED CONCEPTS FOR FILAMENT-WOUND PRESSURE VESSELS ALREADY DEFINED BY RTOP 124-08-11 WILL BE PURSUED AND SUCH ACTIVITIES SPECIFICALLY DIRECTED TOWARDS THE DESIGN REQUIREMENTS OF THE SHUTTLE VEHICLE SYSTEM. IN PARTICULAR, THE FOLLOWING DEVELOPMENTS AND EVALUATIONS WILL BE UNDERTAKEN: 1. ESTABLISH THE BASIS FOR HOOP REINFORCING OF LARGE LOAD-CARRYING PROPELLANT TANKS WHICH ARE PART OF THE SHUTTLE VEHICLE PRIMARY STRUCTURE. 2. ESTABLISH THE DESIGN CRITERIA FOR THIN-BONDED METALLIC LINERS (E.G., LINER ADHESIVES, LINER MATERIALS, ETC) IN GLASS FIBER PRESSURE VESSELS. 3. EVALUATE THE EFFECT OF FLAWS IN OVERWRAPPED LOAD-BEARING LINERS. 4. DEVELOP DATA TO IMPROVE DEFINITION OF OPTIMUM COMPOSITE WORKING STRESS LEVEL AND PROVIDE IMPROVED CONFIDENCE BY APPROPRIATE SUBSCALE PRESSURE VESSEL TEST PROGRAMS. 5. DETERMINE WINDING AND MANDREL FABRICATION REQUIREMENTS TO ACCOMPLISH OPTIMUM GRAPHITE PRESSURE VESSEL DESIGNS. 6. EVALUATE TRADE-OFFS IN COST, RELIABILITY, AND WEIGHT OF PRESSURE VESSELS FABRICATED FROM BOTH GLASS AND GRAPHITE FIBERS.

RTOP NO. 124-09-21 TITLE: SPACE RADIATION SHIELDING AND DOSIMETRY  
ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

#### TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TWO FOLD: FIRST TO DEVELOP THE TECHNOLOGIES REQUIRED FOR THE PROTECTION OF MAN AND RADIATION-SENSITIVE COMPONENTS AND MATERIALS FROM UNDESIRABLE EFFECTS OF THE PARTICULATE SPACE RADIATION ENVIRONMENT. SPECIAL EMPHASIS WILL BE PLACED ON THE EXPERIMENTAL VERIFICATION OF THE SHIELDING EFFECTIVENESS OF COMPOSITE SPACECRAFT MATERIALS. SECOND, TO DEVELOP AND MAINTAIN, FOR USE OF LANGLEY PROJECTS, COMPUTER PROGRAMS THAT WILL DETERMINE THE RADIATION DOSES WITHIN A SPACECRAFT AS A FUNCTION OF ITS TRAJECTORY AND SHIELDING. TO MEET THESE OBJECTIVES, INVESTIGATIONS ARE BEING PERFORMED BOTH IN HOUSE AND ON CONTRACT THAT WILL PROVIDE MORE COMPLETE DATA FROM WHICH THE EFFECTIVENESS OF COMPOSITE SPACECRAFT MATERIALS AS RADIATION SHIELDS CAN BE EVALUATED.

TO DEVELOP THE COMPUTER PROGRAMS A COMPILATION OF THE MOST ACCURATE AND EFFICIENT PROGRAMS FROM SOURCES SUCH AS, OAK RIDGE NATIONAL LABORATORIES AND CERN SWITZERLAND, WAS MADE. THE LATEST ENVIRONMENTAL INPUTS FROM NATIONAL SPACE SCIENCE DATA CENTER ARE USED.



RTOP NO. 124-09-21 TITLE: SPACE RADIATION SHIELDING AND DOSIMETRY  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: RICHMONDS, R. G. TEL. 713-483-3816  
TECHNICAL SUMMARY

RADIATION DOSIMETRY THROUGH THE FIRST APOLLO LUNAR LANDING HAS BEEN COMPLETED WITH MINIMAL RADIATION EXPOSURE. THIS FACT CAN BE DIRECTLY ATTRIBUTED TO TWO FACTS, (1) TIMES IN THE MORE INTENSE REGIONS OF THE VAN ALLEN BELTS HAVE BEEN MINIMAL, AND (2) NO SOLAR FLARE PARTICLE EVENTS HAVE OCCURRED DURING THE TIMES THE SPACECRAFTS HAVE BEEN OUT OF THE PROTECTION PROVIDED BY THE EARTH'S MAGNETIC FIELD. AS MISSION DURATIONS INCREASE THE LOW RATE SECONDARY COMPONENTS OF RADIATION DOSE BECOME IMPORTANT. IN ADDITION, THE INCLUSION OF NUCLEAR POWER SOURCES, E.G., NUCLEAR REACTORS WILL PRODUCE BIOLOGICALLY SIGNIFICANT CONTRIBUTIONS TO TOTAL DOSE. DURING THE NEXT FEW YEARS THE INTERACTION OF SPACE RADIATION WITH MATERIALS AS IT AFFECTS RADIATION TRANSPORT AND ENERGY DEPOSITION AND THE APPLICATION OF THIS KNOWLEDGE TO THE DEVELOPMENT OF IMPROVED SPACE RADIATION DOSIMETRY TECHNIQUES WILL BE STUDIED. IN GENERAL, MSC WILL CONTINUE RESEARCH EFFORTS TO DEVELOP ADVANCED SPACE RADIATION DOSIMETRY CONCEPTS, INCLUDING EVALUATION OF COMPLEX RADIATION SHIELDS REQUIRED FOR PROTECTION FROM NEUTRONS. SPECIFICALLY, MSC WILL CONTINUE RESEARCH EFFORTS TO DETERMINE RADIATION DOSE DISTRIBUTIONS INSIDE THE SPACECRAFT FROM MEASUREMENTS OF RADIATION FLUX AND PARTICLE SPECTRA EXTERNAL TO THE SPACECRAFT.

RTOP NO. 124-09-21 TITLE: SPACE RADIATION SHIELDING AND DOSIMETRY  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: RICHMONDS, R. G. TEL.  
TECHNICAL SUMMARY

WORK WILL CONTINUE ON COMPILATION AND UPDATING OF DATA AND METHODS TO CREATE AN INDUSTRY STANDARD FOR RADIATION CALCULATIONS. CURRENT WORK ON ELECTRON BREMSSTRAHLUNG WILL BE COMPLETED; STUDIES OF ELECTRON AND PROTON TRANSPORT PROCESSES WILL BE CONTINUED. IN-HOUSE STUDIES WILL BE PERFORMED TO DETERMINE THE POSSIBLE ROLE OF ACTIVE SHIELDING SYSTEMS IN SPACE VEHICLES. THE IN-HOUSE EXPERIMENTAL PROGRAM TO DEVELOP MORE EFFICIENT SUPERCONDUCTING MAGNETS WILL BE CONTINUED.

RTOP NO. 124-09-21 TITLE: SPACE RADIATION SHIELDING AND DOSIMETRY  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: VETTE, J. I. TEL. 301-982-6695  
TECHNICAL SUMMARY

(A) TO PRODUCE AND MAINTAIN A TRAPPED RADIATION MODEL ENVIRONMENT AND A SOLAR COSMIC RADIATION MODEL ENVIRONMENT IN FORMS USEFUL TO SPACE ENGINEERS AND SYSTEM PLANNERS WHICH BEST REFLECTS THE CURRENT UNDERSTANDING AND EMPIRICAL KNOWLEDGE OF THE PHENOMENA. (B) TO DISSEMINATE THIS ENVIRONMENT TO USERS IN NASA, OTHER GOVERNMENT AGENCIES, UNIVERSITIES, AND PRIVATE INDUSTRY.

RTOP NO. 124-09-21 TITLE: SPACE RADIATION SHIELDING AND DOSIMETRY  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: REETZ, A. TEL. 202-962-0067  
TECHNICAL SUMMARY

RADIATION EFFECTS AND SHIELDING INFORMATION RELATED TO THE SPACE RADIATION ENVIRONMENT IS BEING COLLECTED, EVALUATED, AND DISSEMINATED TO THE SPACE VEHICLE DESIGNER AND ENGINEER. SPECIFICALLY, THE RADIATION EFFECTS INFORMATION CENTER (REIC) AT BATTELLE MEMORIAL INSTITUTE AND THE RADIATION SHIELDING INFORMATION CENTER (RSIC) AT OAK RIDGE NATIONAL LABORATORY WILL RECEIVE CONTINUED SUPPORT FOR WORK RELATED TO SPACE RADIATION EFFECTS AND SHIELDING. PREPARATION OF A RADIATION EFFECTS HANDBOOK AND A SPACE RADIATION SHIELDING HANDBOOK SUITABLE FOR USE BY SPACE VEHICLE DESIGNERS WAS INITIATED IN FY1969 AND WILL BE CONTINUED IN FY 1970.

RTOP NO. 124-09-22 TITLE: SPACE RADIATION EFFECTS LABORATORY  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE FOR THE MANAGEMENT, OPERATION, AND MAINTENANCE OF THE SPACE RADIATION EFFECTS LABORATORY (SREL). THE LABORATORY IS USED JOINTLY BY SCIENTISTS AND ENGINEERS TO PERFORM RESEARCH IN BASIC PHYSICS, RADIOBIOLOGY, AND THE EFFECTS OF RADIATION ON MATERIALS, COMPONENTS, AND SYSTEMS PLANNED FOR USE IN SPACE. THE LABORATORY IS OPERATED BY THE COLLEGE OF WILLIAM AND MARY UNDER CONTRACT TO THE LANGLEY RESEARCH CENTER. THE OPERATING TIME IS SHARED EQUALLY BETWEEN EDUCATIONAL INSTITUTIONS AND GOVERNMENT AGENCIES.

RTOP NO. 124-09-23 TITLE: GROUND-BASED METEOR OBSERVATIONS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: BROOKS, G. W. TEL. 205-453-1120  
TECHNICAL SUMMARY

IN ORDER TO FILL THE GAP IN METEOROID FLUX DATA WHICH EXISTS BETWEEN THE SMALL PARTICLE DATA AVAILABLE FROM SATELLITES AND LARGE PARTICLE DATA TAKEN BY GROUND-BASED SYSTEMS. THIS WILL BE DONE BY USING LOW LIGHT LEVEL SYSTEMS TO EXTEND GROUND-BASED OPTICAL MEASUREMENTS INTO THE RANGE CURRENTLY COVERED ONLY BY RADAR SYSTEMS. THIS SHOULD PROVIDE ANOTHER PARAMETER WITH WHICH TO CALCULATE THE MASS OF THE INCOMING PARTICLE AND THUS LEAD TO A NARROWING OF THE UNCERTAINTY BAND ABOUT THE MASS-FLUX CURVE: THIS SHOULD LEAD TO BETTER EXTRAPOLATION INTO THE GAP WHERE MEASUREMENTS ARE NOT YET POSSIBLE. THE LOW-LIGHT LEVEL SYSTEM IS PORTABLE AND CAN BE USED FOR STUDIES OF THE METEOR INFLUX AT VARIOUS LOCATIONS.

RTOP NO. 124-09-23 TITLE: GROUND-BASED METEOR OBSERVATIONS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECT IS TO DETERMINE FROM GROUND-BASED RADAR AND OPTICAL OBSERVATIONS OF METEORS THE NATURE OF METEOROIDS IN SPACE OVER THE RANGE OF MASS AND FLUX ANTICIPATED AS BEING A HAZZARD TO FUTURE SPACECRAFT. A MAJOR PORTION OF THE RESEARCH WILL BE ACCOMPLISHED BY CONTRACTING WITH THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY WHO WILL OPERATE THE PATROLS AND ANALYZE MOST OF THE DATA. THIS RESEARCH WILL PROVIDE THE PHYSICAL AND ORBITAL CHARACTERISTICS OF METEOROIDS LEADING TOWARDS THE DEFINITION OF THE METEOROID HAZARD.

RTOP NO. 124-09-24 TITLE: METEOROID ENVIRONMENT MEASUREMENTS IN SPACE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECT IS TO DEVELOP AND FLY THE SENSORS REQUIRED TO PROVIDE THE NEAR-EARTH AND INTERPLANETARY SPACE METEOROID PENETRATION DATA REQUIRED TO SUPPORT GROUND TESTS AND ANALYTICAL STUDY TO DEFINE THE METEOROID HAZARD FOR THE PROPER ENGINEERING DESIGN OF FUTURE SPACE VEHICLES. FLIGHT PENETRATION SENSORS ARE BEING DEVELOPED BOTH IN-HOUSE AND ON CONTRACT FOR THE SCOUT-LAUNCHED "METEOROID TECHNOLOGY SATELLITE", AND FOR SECONDARY EXPERIMENTS ON SUCH SPACECRAFT AS PIONEER AND SATURN S-IVB. THIS RESEARCH WILL PROVIDE THE CROSSLINK DATA REQUIRED TO MOLD THE RESTRICTED GROUND TEST PENETRATION DATA, THE ANALYTICAL STUDIES, AND THE METEOR DATA INTO A METEOROID HAZARD MODEL CONSISTENT WITH PROPER ENGINEERING DESIGN.

RTOP NO. 124-09-24 TITLE: METEOROID ENVIRONMENT MEASUREMENTS IN SPACE

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: COUR-PALIS, B. G. TEL. 713-483-2666

TECHNICAL SUMMARY

A NUMBER OF SENSORS ARE IN VARIOUS STAGES OF DEVELOPMENT AND DEFINITION FOR THE IN-FLIGHT MEASUREMENT OF THE PHYSICAL AND DYNAMICAL PROPERTIES OF METEOROIDS. THESE INCLUDE THE ORBITAL ELEMENTS (SPEED AND DIRECTION), SIZE, TYPE, AND COMPOSITION OF SOLID PARTICLES RANGING IN MASS FROM 10<sup>-11</sup> GRAMS (COSMIC DUST) TO 10<sup>-4</sup> GRAMS. THE SENSOR TYPES UNDER DEVELOPMENT ARE AS FOLLOWS: A. A METEOR ANALYZER THAT MEASURES THE PEAK INTENSITY, THE INTENSITY AS A FUNCTION OF DURATION AND THE INTEGRATED LIGHT EMITTED IN A NUMBER OF DIFFERENT WAVE-LENGTHS DEPENDING ON THE APPLICATION. THE INSTRUMENT WAS COMPLETED TO ENGINEERING PROTOTYPE AND IS BEING CONSIDERED FOR A POSSIBLE EXPERIMENT. B. AN ULTRA-THIN-FILM, CAPACITOR TYPE, TIME-OF-FLIGHT AND DIRECTION MEASUREMENT SYSTEM TO BE USED IN CONJUNCTION WITH PENETRATION DETECTORS OR MOMENTUM TRANSDUCERS. EITHER COMBINATION WILL BE CAPABLE OF DETERMINING THE MASS OF THE IMPACTING METEOROID. A NUMBER OF EXPERIMENTS, CONFIRMED AND IN

PROPOSAL STAGE UTILIZE THESE SENSORS (R/MS; MTS; AND ALSEP).  
CONTINUED----

RTOP NO. 124-09-24 TITLE: METEOROID ENVIRONMENT MEASUREMENTS IN  
SPACE

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: POSTER, J. V. TEL. 415-961-1111

TECHNICAL SUMMARY

EXPERIMENTS ARE BEING DEVELOPED FOR THE PIONEER F/G JUPITER MISSIONS TO PROVIDE REQUIRED DATA ON THE METEOROID HAZARD FOR THE PROPER ENGINEERING DESIGN OF SPACE VEHICLES ON LONG DURATION FLIGHTS TO THE OUTER PLANETS. ONE EXPERIMENT UTILIZES A REFLECTED LIGHT TECHNIQUE, AND HAS THE POTENTIAL OF YIELDING DATA ON SPEED, DIRECTION, (AND HENCE, PARTICLE ORBITS) AND PARTICLE SIZE OVER THE RANGE OF PARTICLE MASSES FROM  $10^{-8}$  TO  $10^{-3}$  GRAMS. A COMPLEMENTARY EXPERIMENT EMPLOYS THE PRESSURIZED CELL TECHNIQUE USED ON EXPLORERS XIII, XVI, AND XXIII, AND ON THE LUNAR ORBITERS, AND IS RESPONSIVE TO PARTICLE MASSES ON THE ORDER OF  $10^{-7}$  GRAMS.

RTOP NO. 124-09-25 TITLE: METEOROID IMPACT AND PROTECTION

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: COUR-PALIS, B. G. TEL. 713-483-2666

TECHNICAL SUMMARY

THE MSC HAS BEEN INVOLVED IN THE AREAS OF METEOROID IMPACT AND PROTECTION SINCE 1963. DURING THIS TIME IT HAS CONDUCTED RESEARCH IN METALLIC AND NON-METALLIC (INCLUDING SPACE SUIT) MATERIALS IN ITS OWN HYPERVELOCITY IMPACT FACILITY IN SUPPORT OF THE APOLLO PROGRAM. THE BACKLOG OF DATA ACCUMULATED IS BEING DISSEMINATED IN THE FORM OF PAPERS PRESENTED AT NASA AND PROFESSIONAL SOCIETY MEETINGS. THOSE PRESENTED DURING FY 69 WERE AS FOLLOWS: (A) THE MSC MINIATURE LIGHT GAS GUN RANGE; (B) MSC DRAG ACCELERATION LAUNCHER; (C) IMPACT CHARACTERISTICS IN GLASS TARGETS; (D) EMPIRICAL HYPERVELOCITY EQUATIONS DEVELOPED FOR PROJECT APOLLO; (E) DEVELOPMENT OF METEOROID PROTECTION FOR EVA SPACE SUITS; AND (F) METEOROID PROTECTION BY MULTI-WALL STRUCTURES. ALONG WITH THE IMPACT AND PROTECTION WORK MSC HAS SOUGHT TO IMPROVE THE METEOROID SIMULATION CAPABILITY OF HYPERVELOCITY LAUNCHERS. IT WAS THE FIRST FACILITY TO CONSISTENTLY LAUNCH AND PHOTOGRAPH IN-FLIGHT VERY SMALL PARTICLES (200 TO 400 DIAMETER) AT VELOCITIES ABOVE 7 KM/SEC. THIS WAS IMPERATIVE FOR THE DEVELOPMENT AND QUALIFICATION OF SPACE SUIT PROTECTION. IT HAS UNDER CONTRACT A MEANS OF INCREASING THE VELOCITY RANGE OF THE ACCELERATED RESERVOIR LIGHT GAS GUN BY MEANS OF A VARIABLE SPEED PISTON. OART SPONSORED RESEARCH IN LAUNCHER DEVELOPMENT CONSISTS OF THREE OTHER----

RTOP NO. 124-09-25 TITLE: METEOROID IMPACT AND PROTECTION  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: COUR-PALIS, B. G. TEL. 205-453-1120  
TECHNICAL SUMMARY

DEVELOPMENT OF THE IN-HOUSE HYPERVELOCITY IMPACT FACILITY WILL CONTINUE. THIS FACILITY IS OPERATIONAL BUT UPGRADING OF THE CAPABILITIES OF BOTH THE LIGHT GAS GUNS AND PLASMA ACCELERATORS WILL BE CARRIED OUT. INSTRUMENTATION WILL BE ADDED TO INCREASE OUR DATA ACQUISITION PER SHOT. WORK WILL CONTINUE WITH CURRENT COMPUTER PROGRAMS TO PREDICT THE BALLISTIC LIMITS OF FINITE PLATES AND AN EFFORT WILL BE STARTED TO DEVELOP A FASTER METHOD OF MAKING THESE CALCULATIONS. WORK WILL BE CONTINUED TOWARD A THEORETICAL MODEL FOR IMPACTS INTO COMPLEX STRUCTURES AND STUDIES OF THE IMPACT FLASH WILL CONTINUE IN AN EFFORT TO BETTER UNDERSTAND THE IMPACT PHENOMENA. AN ATTEMPT WILL BE MADE TO DEVELOP A NEW TYPE OF METEOROID DETECTOR UTILIZING THE PHENOMENA CREATED BY HYPERVELOCITY IMPACT INTO A DIELECTRIC. DURING FY-70 THIS EFFORT WILL BE CONFINED TO A FEASIBILITY STUDY.

RTOP NO. 124-09-25 TITLE: METEOROID IMPACT AND PROTECTION  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO DEVELOP THE UNDERSTANDING OF HYPERVELOCITY IMPACT REQUIRED TO DESIGN FUTURE SPACECRAFT HAVING ADEQUATE METEOROID PROTECTION. IT WILL BE NECESSARY TO CONTINUE DEVELOPMENT OF PARTICLE ACCELERATORS REQUIRED TO SIMULATE HYPERVELOCITY IMPACT AND CONTINUE CURRENT IMPACT STUDIES SUCH AS THE EFFECTIVENESS OF DOUBLE WALL STRUCTURES IN PREVENTING METEOROID PENETRATIONS. IMPACT SENSORS WILL BE EVALUATED AS PART OF A PROGRAM OF MORE ACCURATELY DEFINING THE MICROMETEOROID FLUX IN SPACE. EFFECTS OF MATERIAL, PROJECTILE DENSITY AND SHAPE ON PENETRATION AND CRATERING PHENOMENA WILL BE STUDIED EXPERIMENTALLY AND ANALYTICALLY. RESULTS OF THIS WORK WILL BE NEEDED FOR THE DESIGN OF METEOROID BUMPERS FOR SPACECRAFT AND PARTICULARLY FOR SPACECRAFT TRAVERSING THE ASTEROID BELT.

RTOP NO. 124-09-25 TITLE: METEOROID IMPACT AND PROTECTION  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RESEARCH ARE TO DEVELOP ANALYTICAL PROCEDURES THAT WILL PREDICT THE METEOROID HAZARD TO SPACE VEHICLES, TO PROVIDE THE ANALYTICAL MEANS FOR OPTIMIZING THE PROTECTION FROM SUCH A HAZARD, AND TO DEVELOP AND PLACE INTO OPERATION PARTICLE ACCELERATORS NEEDED TO CONDUCT APPROPRIATE EXPERIMENTAL INVESTIGATIONS FOR SUCH RESEARCH AS WELL AS FOR TESTING ACTUAL SPACECRAFT DESIGNS. THESE OBJECTIVES WILL BE MET BY COMBINED EXPERIMENTAL AND THEORETICAL INVESTIGATIONS INTO THE BEHAVIOR OF MATERIALS AND STRUCTURAL WALL CONFIGURATIONS UNDER METEOROID IMPACT.

THE RESULTS OF THESE STUDIES WILL PROVIDE A MUCH NEEDED SOUND BASIS FOR DESIGN OF LIGHT WEIGHT SHIELDING AGAINST THE HAZARDS OF METEORIODS.

RTOP NO. 124-09-26 TITLE: SPACE VEHICLE THERMAL CONTROL

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: SCHACH, M. TEL. 301-982-5115

TECHNICAL SUMMARY

THIS PROPOSAL IS FOR IMPROVING THE STATE-OF-THE-ART IN THE TEMPERATURE CONTROL OF UNMANNED SPACECRAFT. CURRENT APPROACHES ARE (1) TO DEVELOP THERMAL CONTROL COATINGS WHICH ARE RELATIVELY STABLE IN THE SPACE ENVIRONMENT, (2) TO DEVELOP IMPROVED LABORATORY, PORTABLE, AND IN-FLIGHT DEVICES FOR MEASURING THE THERMAL RADIATIVE PROPERTIES OF SURFACE COATINGS AND FINISHES, AND (3) TO DEVELOP ADVANCED COMPUTER PROGRAMS FOR SPACECRAFT THERMAL ANALYSIS.

RTOP NO. 124-09-26 TITLE: SPACE ENVIRONMENTAL FACTORS - THERMAL CONTROL SYSTEMS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: GUY, W. W. TEL. 713-483-3771

TECHNICAL SUMMARY

THIS RTOP WILL DELINEATE THE REQUIRED EFFORT TO SUPPORT ADVANCED MANNED MISSIONS (OF EARTH ORBITAL AND LUNAR BASE TYPE) IN THE AREA OF SPACE VEHICLE THERMAL CONTROL. INCLUDED WILL BE (A) THE GENERATION OF NEW THERMAL CONTROL CONCEPTS TO ADVANCE THE STATE-OF-THE-ART AND THE LABORATORY DEMONSTRATION OF THE FEASIBILITY OF NEW THERMAL CONTROL CONCEPTS AND (B) ANALYSIS TECHNOLOGY ENHANCEMENT THROUGH THEORY FORMULATION AND COMPUTATIONAL TECHNIQUE DEVELOPMENT (C) ENVIRONMENTAL DEFINITION ACTIVITIES TO INSURE ADEQUATE DESIGN CRITERIA AVAILABILITY AT THE TIME OF MISSION DEFINITION AND (D) DEVELOPMENT BETTER THERMAL ANALYSIS TECHNIQUES FOR FUTURE MANNED SPACECRAFT THERMAL CONTROL ANALYSIS.

RTOP NO. 124-09-26 TITLE: SPACE VEHICLE THERMAL CONTROL

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: GUY, W. W. TEL. 205-453-1120

TECHNICAL SUMMARY

AS A CONTINUATION OF OUR WORK IN THE THERMAL CONTROL FIELD, OUR EFFORTS WILL BE DIRECTED TOWARD SEVERAL METHODS OF IMPROVING NASA'S CAPABILITIES OF CONTROLLING SPACECRAFT TEMPERATURES. ONE EFFORT WILL BE DIRECTED TOWARD IMPROVEMENT OF THE A/E RATIO OF WHITE PAINTS TO A POINT WHERE THEY ARE COMPETITIVE WITH MORE EXOTIC SYSTEMS. IN ORDER TO PROVIDE NECESSARY BACKGROUND KNOWLEDGE FOR THIS DEVELOPMENT EFFORT, OUR LABORATORY STUDIES OF THE DEGRADATION OF THERMAL CONTROL COATINGS WILL CONTINUE AND A SPECIAL EFFORT WILL BE CONDUCTED IN THE STUDY OF THERMAL PROPERTIES OF COATINGS AT CRYOGENIC TEMPERATURES. WORK WILL CONTINUE IN THE DEVELOPMENT OF HEAT STORAGE DEVICES USING PHASE CHANGE MATERIALS.



RTOP NO. 124-09-26 TITLE: SPACE VEHICLE THERMAL CONTROL  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: FOSTER, J. V. TEL. 415-961-1111  
TECHNICAL SUMMARY

THERMAL CONTROL MATERIALS AND TECHNIQUES ARE BEING DEVELOPED WHICH ARE SUITABLE FOR SPACECRAFT USE ON INTERPLANETARY MISSIONS. BECAUSE ALL SPACECRAFT HAVE EXTERIOR SURFACES WHICH MUST REACT WITH THE SPACE RADIATION AND THERMAL ENVIRONMENT, SPACE SIMULATION EXPOSURE TECHNIQUES MUST BE DEVELOPED TO PROVIDE REALISTIC LABORATORY EVALUATIONS. IN-SITU STUDIES OF THE INFLUENCE OF RADIATION SPECIES, ENERGY, FLUENCE AND SURFACE TEMPERATURE IN A HIGH VACUUM ENVIRONMENT ARE COMPARED WITH FLIGHT EXPERIMENT DATA. POTENTIAL COATING PIGMENTS SELECTED BY A MATERIAL SCIENCE ORIENTED STUDY OF COLOR-CENTER PRODUCING DEFECTS ARE BEING INVESTIGATED TO PROVIDE AN UNDERSTANDING OF DEGRADATION PHENOMENA. PARTICULAR EMPHASIS IS BEING PLACED ON COMBINED ENVIRONMENTS OF SOLAR WIND PROTONS AND SOLAR ULTRAVIOLET RADIATION BECAUSE OF THE CONCENTRATED ENERGY DEPOSITION IN OR NEAR THE EXPOSED SURFACE. STUDIES OF THE OPTICAL PROPERTIES AND HEAT CONDUCTION OF THIN METALLIC FILMS USED FOR CONTROLLING RADIATIVE HEAT TRANSFER ARE BEING CONDUCTED. APPLICATIONS OF THESE STUDIES WILL BE MADE TO ENGINEERING PROBLEMS SUCH AS MULTIPLE LAYER INSULATION. IN ADDITION TO PASSIVE TECHNIQUES, THE NEWLY DEVELOPED HEAT PIPE TECHNOLOGY WILL BE EXTENDED TO PROVIDE A VARIABLE CONDUCTANCE, CONSTANT TEMPERATURE DEVICE FOR ACCURATE TEMPERATURE CONTROL OF CRITICAL COMPONENTS.

RTOP NO. 124-09-26 TITLE:  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: MCDONALD, R. R. TEL. 213-354-6186  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE THE TECHNOLOGY NECESSARY TO INSURE THAT ADEQUATE TEMPERATURE CONTROL OF THE SPACECRAFT PLANNED FOR THE NEW MISSIONS NOW BEING CONSIDERED CAN BE ACCOMPLISHED. THESE MISSIONS, TRAVELING IN TOWARDS MERCURY AND THE SUN, AND OUTWARD AWAY FROM THE SUN TO THE OUTER PLANETS, POSE SOME NEW AND SEVERE THERMAL PROBLEMS. THIS TECHNOLOGY WILL BE PROVIDED BY A PROGRAM OF RESEARCH IN FOUR BROAD AREAS: (1) DEFINITION OF THERMAL CONTROL REQUIREMENTS AND IDENTIFICATION OF NECESSARY ADVANCES. (2) DEVELOPMENT OF ADVANCED ANALYTICAL AND DESIGN TECHNIQUES THAT WILL ALLOW BETTER PREDICTION OF SPACECRAFT HEAT TRANSFER. (3) DEVELOPMENT OF SELECTED TEMPERATURE CONTROL DEVICES WHICH CAN BE USED FOR MORE EFFECTIVE SPACECRAFT TEMPERATURE CONTROL DESIGN. THESE DEVICES WILL TYPICALLY BE AIMED AT CONTROLLING OR MODIFYING THE FLOW OF HEAT BETWEEN VARIOUS PARTS OF THE SPACECRAFT, BETWEEN THE SPACECRAFT AND SPACE, OR TO MEASURE SOME PARTICULAR HEAT TRANSFER PARAMETER. (4) IMPROVEMENTS IN THE TECHNOLOGY OF MATERIALS SELECTION, UTILIZATION AND PERFORMANCE OF TEMPERATURE CONTROL INSULATIONS, DEVICES, AND COATING SYSTEMS.



RTOP NO. 124-09-26 TITLE: SPACE VEHICLE THERMAL CONTROL  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

IN THE SPACE VEHICLE THERMAL CONTROL AREA, A COMPREHENSIVE EXPERIMENTAL AND THEORETICAL PROGRAM, BOTH IN-HOUSE AND ON CONTRACT, IS IN PROCESS TO DEFINE, STUDY, AND DEVELOP SOLUTIONS TO THERMAL CONTROL ADVANCED TECHNOLOGY PROBLEMS ASSOCIATED WITH UNMANNED SPACE VEHICLES. A CONTRACT WITH CONVAIR DIVISION OF GENERAL DYNAMICS CORPORATION TO DESIGN AND CONSTRUCT A "SPACE ENVIRONMENTAL EFFECTS SYSTEM", WILL BE COMPLETED. THE COMPLETION OF THIS SYSTEM, FUNDED IN FISCAL 1969, WILL PROVIDE US WITH THE IN-HOUSE CAPABILITY TO STUDY THE CRITICAL EFFECTS OF VACUUM, TEMPERATURE, ULTRAVIOLET RADIATION, AND LOW ENERGY ELECTRONS AND PROTONS ON THE THERMAL RADIATION PROPERTIES OF SPACECRAFT THERMAL CONTROL COATINGS. A CRITICAL ASSESSMENT OF THERMAL CONTROL COATINGS WILL BE MADE IN-HOUSE WITH EMPHASIS ON PIGMENT PARTICLE SIZE, METALLIZED POLYMERIC FILMS, PLASTIC INSULATORS, ANODIZED COATING CHEMICAL CONVERSION AND REACTION COATINGS AND SURFACE FINISH. RESEARCH ACTIVITIES IN SUN SHADING SYSTEMS, LOW TEMPERATURE HEAT PIPES, CONTACT SURFACE PHENOMENA, AND ALBEDO SIMULATION WILL BE ADVANCED. THIS RESEARCH IS DIRECTED AT PROVIDING THE TECHNOLOGY FOR THE FUTURE LONG DURATION INTERPLANETARY MISSIONS AND LARGE ORBITING ASTRONOMICAL TELESCOPES.

RTOP NO. 124-09-26 TITLE: SPACE VEHICLE THERMAL CONTROL  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: HOOK, C. TEL. 202-962-4738  
TECHNICAL SUMMARY

THIS PROPOSAL COVERS A BROAD PROGRAM OF IDENTIFICATION, EXTRACTION, EVALUATION, AND SYSTEMIZATION OF DATA ON THE THERMAL RADIATIVE PROPERTIES OF SOLID MATERIALS OF TECHNOLOGICAL INTEREST TO NASA AND IN PARTICULAR THOSE INVOLVED IN THE THERMAL DESIGN OF SPACECRAFT. A LARGE QUANTITY OF DATA IS BEING GENERATED ON THE REFLECTANCE AND EMITTANCE OF THERMAL RADIATIVE ENERGY BY SOLID MATERIALS AT VARIOUS WAVELENGTHS AND THIS CONTINUING EFFORT ATTEMPTS TO BRING ALL REPORTED DATA OF SIGNIFICANCE INTO PROPER VIEW AND PERSPECTIVE PERMITTING THERMAL DESIGNERS ACCESS TO OTHERWISE ELUSIVE OR UNAVAILABLE DATA, AND WHERE POSSIBLE, FORESTALL USELESS DUPLICATION OF MEASUREMENTS.

RTOP NO. 124-09-27 TITLE: THERMAL/VACUUM TESTING TECHNOLOGY  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROPOSED RTOP ARE TO (1) DEVELOP METHODS FOR MEASURING THERMAL/VACUUM EFFECTS ON SPACE VEHICLE MATERIALS, (2) DEVELOP ACCELERATED TESTING TECHNIQUES FOR THERMAL VACUUM MEASUREMENTS, AND (3) DEVELOP METHODS FOR VACUUM MEASUREMENTS AND STANDARDS FOR VACUUM GAUGE CALIBRATIONS. THE OBJECTIVE WILL BE ACCOMPLISHED WITH A BALANCED PROGRAM OF IN-HOUSE RESEARCH SUPPORTED

BY CONTRACTS AS REQUIRED. EXPERIMENTAL METHODS FOR MEASURING THERMAL/VACUUM EFFECTS ON THE MECHANICAL AND THERMAL PROPERTIES ARE BEING DEVELOPED AND USED TO IDENTIFY VACUUM DEGRADATION PHENOMENA IN GENERAL CLASSES OF MATERIALS. WHEN THE DEGRADATION PHENOMENA IS ELUCIDATED, THE PARAMETERS FOR ACCELERATING THE PHENOMENA WILL BE SELECTED. VACUUM MEASUREMENT CAPABILITY AND STANDARDS FOR VACUUM GAUGE CALIBRATION ARE NEEDED TO SUPPORT THE MEASUREMENT PROGRAMS. THE RESULTS OF THIS RTOP WILL PROVIDE THE TECHNOLOGY NEEDED FOR THERMAL/VACUUM TESTING OF SPACE VEHICLE MATERIALS.

RTOP NO. 124-09-27 TITLE: THERMAL/VACUUM TESTING TECHNOLOGY

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: KRUGER, R.

TEL. 301-982-5034

TECHNICAL SUMMARY

THIS RTOP IS BASICALLY INTENDED TO IMPROVE SPACE SIMULATOR TEST TECHNIQUES. THIS AREA INCLUDES IMPROVED METHODS FOR SIMULATING THE VACUUM ENVIRONMENT, THE EXTRA-TERRESTRIAL SOLAR ENVIRONMENT, AND THE PLANETARY ALBEDO AND INFRARED EMITTED ENERGY. CONCOMITANT WITH THESE OBJECTIVES IS THE IMPROVEMENT OF MEASUREMENT AND ANALYSIS TECHNIQUES AND DEFINITION OF THE REQUIREMENTS FOR TESTING, E.G., REQUIREMENTS FOR VACUUM LEVEL, SOLAR SPECTRAL MATCH AND CONTAMINATION LEVELS. PRIOR WORK HAS ALSO INCLUDED MEASUREMENT OF THE ACTUAL SOLAR SPECTRUM TO BETTER DEFINE THE SIMULATION. THE WORK IS INTENDED TO INCREASE THE ASSURANCE OF SUCCESSFUL SPACECRAFT MISSIONS BY IMPROVING TEST TECHNIQUES. CURRENT APPROACHES INCLUDE DEVELOPMENT OF LONG-TERM, CLEAN, VACUUM SYSTEMS CAPABLE OF UNATTENDED OPERATION. THE INVESTIGATION OF VORTEX STABILIZED ARC FOR BETTER SOLAR SIMULATION; CONTAMINATION PHENOMENA ASSOCIATED WITH VACUUM TESTING, INSTRUMENTS FOR IN-TEST MONITORING, AND STATISTICAL APPROACHES FOR ERROR ANALYSIS.

RTOP NO. 124-09-27 TITLE: THERMAL/VACUUM TESTING TECHNOLOGY

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: CHIMENTI, E. T.

TEL. 713-483-3676

TECHNICAL SUMMARY

THE IMPORTANT ROLE OF THERMAL VACUUM TESTING FOR SUCCESSFUL THERMAL CONTROL DESIGN VERIFICATION OF MANNED SPACECRAFT SYSTEMS HAS BEEN FIRMLY ESTABLISHED. THE INCREASING SIZE AND STRUCTURAL COMPLEXITY OF FUTURE SPACECRAFT ASSEMBLAGES WILL EXCEED THE CAPABILITIES OF THE LARGEST EXISTING SPACE SIMULATION CHAMBERS FOR FULL-SCALE PROTOTYPE TESTING. BY THERMALLY SCALING SPACECRAFT ASSEMBLAGES TO BE COMPATIBLE WITH EXISTING FACILITIES, THE CONCEPT OF THERMAL SCALE MODELING OFFERS THE POTENTIAL OF DETERMINING THERMAL PERFORMANCE OF SPACECRAFT SYSTEMS DESIGNS WHICH WOULD OTHERWISE BE IMPOSSIBLE. DURING THE PAST FEW YEARS, IT HAS BEEN DEMONSTRATED THAT REDUCED-SCALE THERMAL MODELS CAN BE USED IN THE PREDICTION OF STEADY STATE TEMPERATURES OF PROTOTYPE UNMANNED SPACECRAFT. FURTHER DEVELOPMENT AND IMPROVEMENTS IN TRANSIENT THERMAL SCALE MODELING TECHNIQUES AND THE EXTENSION OF THESE TECHNIQUES TO LARGE MANNED SPACE CRAFT DESIGNS ARE REQUIRED. THE OBJECTIVES OF THIS PROGRAM ARE

TO DETERMINE, DEVELOP, AND DEMONSTRATE THE CAPABILITIES OF THERMAL SCALE MODELING AS A THERMAL DESIGN AND VERIFICATION METHOD FOR LARGE MANNNED SPACECRAFT SYSTEMS INCLUDING LARGE RADIATOR/FLUID SYSTEMS ENVISIONED FOR ADVANCED MISSIONS.

RTOP NO. 124-09-27 TITLE: SPACE SIMULATION TESTING TECHNOLOGY

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MCDONALD, R. R. TEL. 213-354-6186

TECHNICAL SUMMARY

THE OBJECTIVE IS TO ADVANCE THE STATE OF THE ART IN SPACE ENVIRONMENT SIMULATION TECHNOLOGY. THE THREE AREAS OF THIS TECHNOLOGY WHICH WILL BE ATTACKED ARE; 1) SOLAR SIMULATION FOR THERMAL VACUUM TESTING OF SPACECRAFT; 2) SPACE MOLECULAR FLUX SIMULATION FOR COLDWELDING TESTS OF SPACECRAFT MECHANISMS, AND 3) COMBINATION OF RADIATION AND MOLECULAR FLUX SIMULATION FOR EVALUATION OF SPACECRAFT COATINGS. APPLICATIONS OF THE IMPROVED TECHNOLOGY WILL BE PRIMARILY IN EXISTING JPL FACILITIES ALTHOUGH OTHER GOVERNMENT INSTALLATIONS WILL BE ABLE TO USE IT ALSO. BETTER SOLAR SIMULATION WILL BE SOUGHT BY INCREASING THE BRIGHTNESS OF LIGHT SOURCES WHICH WOULD ALLOW ANY OF SEVERAL PERFORMANCE CHARACTERISTICS TO BE IMPROVED. MOLECULAR FLUX STUDIES WILL INCLUDE CONTINUED EVALUATION OF THE JPL MOLSINK AND EXPERIMENTS WITH A FRICTION TEST MODULE FOR WHICH IN-SPACE CHARACTERISTICS ARE AVAILABLE. THE COMBINED ENVIRONMENT WORK CONSISTS OF THE INCLUSION OF SOLAR PHOTON AND SOLAR WIND GENERATORS IN THE MOLSINK AND AN EVALUATION OF THE USEFULNESS OF THE COMBINATION OF IN-SITU EVALUATION OF SPACECRAFT COATINGS.

RTOP NO. 124-09-28 TITLE: OPTICAL CONTAMINATION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MCDONALD, R. R. TEL. 205-453-1120

TECHNICAL SUMMARY

IN ORDER TO CONTINUE THE OPTICAL CONTAMINATION EFFECTS WORK AT MSFC AND TO PROVIDE NECESSARY GROUND SUPPORT DATA FOR EXPERIMENTS T-027 AND T-030 IT IS ESSENTIAL THAT CERTAIN LABORATORY EQUIPMENT BE ADDED TO OUR EXISTING FACILITIES. THIS WILL BE IN NATURE OF A ONE-TIME CAPITAL EXPENDITURE. REQUIREMENTS IN FUTURE YEARS SHOULD DROP SHARPLY AND REMAIN AT A MAINTENANCE LEVEL. THIS PROGRAM IS PART OF THE OVERALL MSFC PROGRAM IN THIS AREA, BUT IT IS VITAL TO THE UNDERSTANDING OF THE DEGRADATION OF THE OPTICAL PROPERTIES OF ASTRONOMICAL INSTRUMENTS USED ON MANNED SATELLITES.

RTOP NO. 124-09-29 TITLE: RADIATION PHYSICS AND CHEMISTRY OF MATERIALS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE BEHAVIOR OF MATERIALS IN A RADIATION FIELD GREATLY INFLUENCES THE RELIABILITY AND PERFORMANCE OF COMPONENTS AND SYSTEMS

WHICH MUST FUNCTION EFFECTIVELY IN INTERPLANETARY SPACE AND WITHIN PLANETARY MAGNETOSPHERES. THE PERFORMANCE OF SYSTEM FUNCTIONS ON MULTI-YEAR MISSIONS IN HIGH INTENSITY RADIATION FIELDS REQUIRES MATERIALS OF MAXIMUM RADIATION STABILITY, WHICH CAN BEST BE DEVELOPED AFTER A SOUND BASIS OF FUNDAMENTAL INFORMATION IS ESTABLISHED. STUDIES OF THE RADIATION PHYSICS AND CHEMISTRY OF MATERIALS ARE THEREFORE DIRECTED TOWARD: 1. DETERMINATION OF THE CAUSE AND EXTENT OF RADIATION DEGRADATION. 2. ACCUMULATION OF DESIGN DATA. 3. DEVELOPMENT OF MATERIALS WITH IMPROVED RADIATION RESISTANCE. MATERIALS UNDER INVESTIGATION INCLUDE SEMICONDUCTORS, ELECTRONIC AND OPTICAL COMPONENTS AND PHOTOGRAPHIC FILM. PROPERTIES OF INTEREST ARE DIELECTRIC CONSTANT, CONDUCTIVITY, PHOTOGRAPHIC IMAGING AND CONTRAST, AND SEMICONDUCTOR DEFECT PRODUCTION.

RTOP NO. 124-12-05 TITLE: SPACE VEHICLE DESIGN CRITERIA  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: CARROLL, F. J. TEL. 617-494-2032  
TECHNICAL SUMMARY

OBJECTIVES: PREPARATION AND PUBLICATION OF ENGINEERING CRITERIA IN THE FORM OF NASA DESIGN CRITERIA MONOGRAPHS BASED ON AN ASSESSMENT OF THE RESULTS OF SPACE VEHICLE RESEARCH, DESIGN AND OPERATIONS AND OPERATIONS AND WHICH ARE TECHNICALLY CORRECT AND REPRESENT THE VIEWS OF THE MAJORITY OF THE EXPERIENCED PEOPLE IN THE FIELD. MONOGRAPH DOCUMENTS WILL CONTRIBUTE TO THE SOLUTION OF DESIGN AND OPERATIONAL PROBLEMS RELATED TO FUTURE SPACE VEHICLES E.G., ON-BOARD MECHANICAL, ELECTRICAL/ELECTRONIC FAILURES LEADING TO COMPROMISED MISSION OBJECTIVES, BY PROVIDING GUIDELINES WITH WHICH TO ASSESS THE IMPORTANT FACTORS NECESSARY FOR QUALITY EQUIPMENT AND SYSTEMS. APPLICATIONS: MONOGRAPH DOCUMENTS WILL HAVE APPLICATION TO MOST FUTURE NASA SPACE VEHICLE DESIGNS AND DEVELOPMENTS. NEW GUIDANCE AND CONTROL, INSTRUMENTATION COMMUNICATIONS, AND POWER SYSTEMS FOR EARTH ORBITAL, LUNAR AND INTERPLANETARY SPACE VEHICLES WILL BE IMPROVED, BY VIRTUE OF THE DOCUMENTATION OF PAST LEARNING AND PRACTICE. APPROACH: EACH MONOGRAPH DOCUMENT PREPARED IS WRITTEN WITH THE ASSISTANCE OF A SPACE VEHICLE DESIGN ADVISORY PANEL FULLY COORDINATED AND PARTICIPATING UNDER THE DIRECTION OF A PRINCIPAL INVESTIGATOR AND THE ERC DESIGN CRITERIA OFFICE.

RTOP NO. 124-12-06 TITLE: SPACE VEHICLE DESIGN CRITERIA  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: MILLS, S. A. TEL. 301-982-4246  
TECHNICAL SUMMARY

TO DEVELOP AND PUBLISH (1) NASA DESIGN CRITERIA FOR TERRESTRIAL AND EXTRATERRESTRIAL ENVIRONMENTS AND (2) GSFC ENVIRONMENTAL TEST SPECIFICATIONS. FOR THIS TASK, WE ASSESS DATA FROM THREE SOURCES: SPACE AND TERRESTRIAL RESEARCH, SPACECRAFT OPERATIONAL PERFORMANCE, AND ENVIRONMENTAL TEST EXPERIENCE. THE OBJECTIVE, WHICH IS TO IMPROVE DESIGN AND PERFORMANCE OF SPACE SYSTEMS, IS CARRIED OUT IN THREE COMPLEMENTARY WAYS: (1) DEVELOPMENT OF SOME 30 NASA DESIGN CRITERIA MONOGRAPHS, EACH OF WHICH PRESENTS ENGINEERING DESCRIPTION

AND/OR A MODEL OF AN ENVIRONMENT WHICH CAN AFFECT THE DESIGN OF SPACE VEHICLES AND THE PLANNING OF SPACE MISSIONS. AS LEAD CENTER, GSFC INITIATES, COORDINATES, AND REVIEWS EFFORTS OF PARTICIPATING NASA CENTERS, AND CONTRIBUTING SCIENTISTS, ENGINEERS, AND CONTRACTORS. (2) FORMULATION OF GSFC GENERAL SPECIFICATIONS FOR TESTING SPACECRAFT. REVISION ARE MADE IN RESPONSE TO NEW ENVIRONMENTAL KNOWLEDGE OR WHEN NASA ADOPTS NEW LAUNCH VEHICLES. (3) THE PAST EXPERIENCE AND PERFORMANCE (PEP) EFFORT COMPARES ACTUAL SPACECRAFT OPERATIONAL RESULTS WITH PRIOR ENVIRONMENTAL TESTS. THE OBJECT IS TO IMPROVE THE TEST PROGRAM AND ATTAIN MAXIMUM RELIABILITY IN SPACE PERFORMANCE.

RTOP NO. 124-12-07 TITLE: SPACE VEHICLE DESIGN CRITERIA  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: MCDONALD, R. R. TEL. 213-354-0186  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PREPARE A SET OF ENVIRONMENTAL DESIGN CRITERIA FOR THE PLANETS REQUIRED FOR SPACE VEHICLE DESIGN, AND TO SUPPORT AT A LEVEL OF APPROXIMATELY ONE-MAN-YEAR THE SPACE VEHICLE DESIGN CRITERIA PROGRAM IN THE AREAS OF STRUCTURES, GUIDANCE AND CONTROL, CHEMICAL PROPULSION AND ENVIRONMENTS. THIS EFFORT IS IN DIRECT SUPPORT OF THE NASA SPACE VEHICLE DESIGN CRITERIA PROGRAM. THE CURRENT EFFORT IS DIRECTED TOWARD COMPLETING SPACE VEHICLE DESIGN CRITERIA DOCUMENTS FOR THE MARS SURFACE AND THE PLANET JUPITER, CONTINUING THE EFFORT TO DEVELOP A DESIGN CRITERIA DOCUMENT FOR THE PLANET MERCURY AND INITIATING THE DEVELOPMENT OF A DESIGN CRITERIA DOCUMENT FOR THE PLANET SATURN DURING FY-'70. TOGETHER WITH KNOWLEDGEABLE SCIENTISTS, ENGINEERS, AND DESIGNERS IMPORTANT ENVIRONMENTAL PARAMETERS WILL BE IDENTIFIED. BASED ON THE CURRENT STATE-OF-THE-ART KNOWLEDGE OF THE SPECIFIED ENVIRONMENT, ENGINEERING DESCRIPTIONS, AND/OR MODELS WILL BE DEVELOPED AND SPACE VEHICLE DESIGN CRITERIA FOR THE IMPORTANT ENVIRONMENTAL PARAMETERS ESTABLISHED. AN ENVIRONMENTAL DESIGN CRITERIA DOCUMENT WILL BE COMPOSED, EDITED, AND WRITTEN IN THE ESTABLISHED STYLE. THE DOCUMENTS PASS THROUGH THE REGULAR REVIEW CYCLE, AND THEN THE FINAL DRAFT IS SENT TO GSFC FOR PUBLICATION.

RTOP NO. 124-12-08 TITLE: SPACE VEHICLE DESIGN CRITERIA  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: MCDONALD, R. R. TEL. 703-827-0000  
TECHNICAL SUMMARY

OBJECTIVE: TO DEVELOP AND DOCUMENT FOR USE OF NASA FLIGHT PROGRAMS AND THEIR CONTRACTORS SOUNDLY-CONCEIVED AND AUTHORITATIVE GUIDELINES FOR THE DESIGN OF FLIGHT-WORTHY SPACE VEHICLE STRUCTURE (NASA POLICY DIRECTIVE 8070.1). THE GUIDELINES SHOULD BE POSED ON THE CURRENT STATE OF THE ART USING THE MOST APPROPRIATE AND KNOWLEDGEABLE PEOPLE FROM GOVERNMENT, INDUSTRY, AND UNIVERSITIES. RESULTS ARE TO BE SUMMARIZED AND PUBLISHED IN DESIGN CRITERIA MONOGRAPHS (SP-8000 SERIES), EACH TREATING A STRUCTURAL PROBLEM OF CONCERN TO NASA FLIGHT PROGRAMS OR THEIR CONTRACTORS. APPROACH: AS LEAD CENTER, LANGLEY ESTABLISHES SUBJECTS AND PRIORITIES AND ARRANGES

FOR AND COORDINATES PARTICIPATION OF TECHNICAL SPECIALISTS FROM THE NASA, INDUSTRY, AND ELSEWHERE TO ASSIST IN THE ASSESSMENT OF AVAILABLE INFORMATION AND IN THE PREPARATION, REVIEW, EVALUATION, AND UPDATING OF MONOGRAPHS. IN ADDITION, THE CENTER ARRANGES FOR REVIEW OF MONOGRAPHS PREPARED BY OTHER NASA CENTERS. THE SPACE VEHICLE DESIGN CRITERIA OFFICE (SVDCO), REPORTING TO THE ASSISTANT DIRECTOR FOR FLIGHT PROJECTS, COORDINATES THIS ACTIVITY FOR LANGLEY, WORKING WITH DESIGNATED CONTACTS AT OTHER NASA CENTERS AND JPL AND WITH NASA TECHNICAL ADVISORS FAMILIAR IN THE SUBJECT AREA. A LANGLEY DESIGN CRITERIA STEERING COMMITTEE, REPORTING TO THE DIRECTOR, ADVISES SVDCO ON SUBJECT PRIORITIES AND RECOMMENDS ON PROGRAM POLICY. THE MAJOR SHARE OF MONOGRAPH DEVELOPMENT EFFORT IS PERFORMED BY CONTRACT AUTHORS AND CONSULTANTS THROUGH A PRIME CONTRACTOR, MCDONNELL DOUGLAS CORPORATION (NAS1-6024). MONOGRAPH REVIEWS ARE SOLICITED FROM INDUSTRY BY THE PRIME CONTRACTOR AND FROM OTHER NASA CENTERS AND GOVERNMENT BY THE DIRECTOR, LRC. LANGLEY AD HOC COMMITTEES EVALUATE ALL INDUSTRY AND NASA COMMENTS AND RECOMMEND ON DISPOSITION OF COMMENTS AND PUBLICATION.

RTOP NO. 124-12-09 TITLE: DESIGN CRITERIA  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: DOUGLASS, H. W. TEL. 433-4000  
TECHNICAL SUMMARY

THIS PROGRAM IS DIRECTED AT THE DEVELOPMENT AND PUBLICATION OF UNIFIED DESIGN CRITERIA FOR CHEMICAL ROCKET PROPULSION, INCLUDING BOTH LIQUID AND SOLID PROPELLENTS. THE PUBLICATIONS ARE TO BE COMPLETE AND AUTHORITATIVE DOCUMENTS FOR USE BY DESIGNERS AND PROJECT MANAGERS IN DESIGNING FUTURE SPACE PROPULSION SYSTEMS AND IN IMPROVING PRESENT SYSTEMS. THE DOCUMENTS WILL BE IN THE FORM OF DESIGN CRITERIA MONOGRAPHS RELATING TO PARTICULAR PROPULSION COMPONENTS, SUBSYSTEMS, OR SYSTEMS. EACH MONOGRAPH WILL DISCUSS THE RELATED STATE OF THE ART, ESTABLISH DESIGN CRITERIA, PRESENT RECOMMENDED PRACTICES, AND REFERENCE LITERATURE USED AS THE BASIS FOR THE CRITERIA. THE MONOGRAPHS ARE BEING WRITTEN BY CONTRACTORS SELECTED BY THE NASA ON THE BASIS OF COMPETENCE, ACKNOWLEDGED LEADERSHIP IN THEIR FIELDS, AND ABILITY TO ESTABLISH AUTHORITATIVE AND RELIABLE DESIGN CRITERIA. THE CONTRACTOR ALSO PREPARES A DOSSIER CONTAINING THE MATERIAL UPON WHICH THE MONOGRAPH IS BASED, FOR RETENTION BY NASA FOR REFERENCE.

RTOP NO. 124-12-10 TITLE: SPACE VEHICLE DESIGN CRITERIA  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: COUR-PALIS, B. G. TEL. 713-483-2666  
TECHNICAL SUMMARY

TO DATE A SPACE VEHICLE DESIGN CRITERIA ENTITLED "METEOROID ENVIRONMENT MODEL 19 69 (NEAR EARTH TO CISELUNAR)", SP-8013, HAS BEEN COMPLETED AND PRINTED AND IS BEING REVIEWED BY THE CENTERS. AN INTERPLANETARY METEOROID ENVIRONMENT MODEL HAS BEEN FINALIZED AND APPROVED BY THE FORMULATING COMMITTEE. IT IS CURRENTLY BEING EXTENDED AND IS DUE FOR FINAL REVIEW IN 10/69. KNOWLEDGE OF THE



METEOROID AND A STERIOD POPULATIONS AS WELL AS THE SOLAR, COSMIC AND GEOMAGNETICALLY TRAPPED RADIATIONS WILL BE ASSESSED AND RECOMMENDED VALUES GIVER FOR ENGINEERING APPLICATION AND MISSION STUDIES. THESE MONOGRAPHS WILL BE REVIEWED BY NASA AND NON-NASA SCIENTISTS AND ENGINEERS TO INSURE THAT THE RESULTS ARE CONSISTENT WITH THE STATE OF THE ART. TO DATE A ROUGH DRAFT OF A SPACE VEHICLE DESIGN CRITERIA MONOGRAPH ENTITLED "CHANGED PARTICLE RADIATION, HAS BEEN COMPLETED BY T. T. WHITE (TG52) AND SUBMITTED TO OART-NASA HQS. FOR CONSIDERATION.

RTOP NO. 124-12-11 TITLE: SPACE VEHICLE DESIGN, CRITERIA  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: COUR-PALIS, B. G. TEL. 205-453-1120  
TECHNICAL SUMMARY

THIS RTOP IS DIVIDED INTO TWO AREAS OF EFFORT, (A) ENVIRONMENTAL CRITERIA AND (B) STRUCTURES DESIGN CRITERIA AND EACH IS DEFINED IN DETAIL AS TO JUSTIFICATION AND OBJECTIVES. MONOGRAPHS OF VARIOUS ENVIRONMENTS WILL BE PRODUCED FOR SCIENTISTS, ENGINEERS AND DESIGNERS AND WILL REFLECT THE LATEST DATA AVAILABLE FOR EACH. THIS DATA PROVIDES THE ENVIRONMENTAL CRITERIA TO WHICH FUTURE VEHICLES MUST BE DESIGNED AND BUILT. A SERIES OF METALS ALLOYS HANDBOOKS, SOME TO BE UPDATED AND REVISED, AND OTHERS TO BE PRODUCED, WILL REFLECT THE LATEST USEABLE INFORMATION ON ALLOYS IN THE DESIGN AND FABRICATION OF SPACE VEHICLES. ALL OF THESE DATA HANDBOOKS ARE NEEDED FOR ANY FOLLOW ON EFFORTS IN THE SPACE STATION-VEHICLE PROGRAM.

RTOP NO. 125-06-05 TITLE: PILOT-MANAGED CONCEPTS FOR AIRCRAFT  
GUIDANCE AND CONTROL

ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-2280  
TECHNICAL SUMMARY

THE CURRENT COMMERCIAL JET AIRCRAFT AND THE JUMBO JET WHICH WILL SOON BE IN SERVICE ARE INCORPORATING INTO THEIR CONTROL, GUIDANCE AND NAVIGATION SYSTEMS SOME DEGREE OF AUTOMATION. BECAUSE OF ADVANCES IN ELECTRONIC SYSTEMS, THESE AIRCRAFT WILL ALSO HAVE SOME INCREASED CAPACITY FOR PRECISION IN ENROUTE AND TERMINAL AREA NAVIGATION. HOWEVER, MOST IMPROVEMENTS ARE ADD-ONS OR MODIFICATIONS TO EXISTING SYSTEMS. CURRENT AMES RESEARCH TASKS HAVE BEEN DIRECTED TO A REVIEW OF ELECTRONIC SYSTEM CAPABILITIES AND PILOT AND AIRCRAFT REQUIREMENTS TO PLAN A SYSTEMATIC APPROACH TO RESULT IN PROMISING SYSTEM CRITERIA FOR SATISFACTION OF REQUIREMENTS. AN ADVISORY GROUP WITHIN AMES RESEARCH CENTER HAS BEEN ESTABLISHED TO CARRY OUT THIS TASK. CONTACT HAS BEEN MADE WITH THE ELECTRONICS RESEARCH CENTER TO PLAN A COORDINATED PROGRAM IN THIS AREA UTILIZING THE SPECIFIC CAPABILITIES OF BOTH CENTERS.



RTOP NO. 125-06-08 TITLE: AUTOMATIC APPROACH & LANDING  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: WEDAN, R. TEL. 617-494-2467  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP AND FLIGHT TEST TECHNIQUES WHICH WILL LEAD TO SIGNIFICANT IMPROVEMENT IN THE SAFETY, RELIABILITY, AND OPERATIONAL EFFECTIVENESS OF PILOT MANAGED AUTOMATIC ALL WEATHER APPROACH, LANDING, GO AROUND, AND DEPARTURE GUIDANCE AND CONTROL SYSTEMS FOR CONVENTIONAL TRANSPORT AIRCRAFT. THIS GOAL WILL BE ACHIEVED PRIMARILY BY MORE EXTENSIVE UTILIZATION OF EXISTING ON BOARD AVIONIC EQUIPMENT, EXISTING GROUND BASED NAVIGATION AIDS, AND OTHER EXISTING GROUND BASED FACILITIES BY EXPLOITING SYNERGETIC SYSTEM AND HYBRID SYSTEM CONCEPTS WHICH LINK THESE AVAILABLE RESOURCES TOGETHER VIA ADDITIONAL INTERFACES AND MORE EXTENSIVE USE OF ON BOARD COMPUTATION. SUCCESS OF THIS RESEARCH PROGRAM WILL DEMONSTRATE THE FEASIBILITY OF METHODS WHICH IF IMPLEMENTED WOULD SIGNIFICANTLY INCREASE AIR TERMINAL CAPACITIES AND MORE EFFECTIVELY UTILIZE THE NATIONAL AIR TRANSPORTATION SYSTEM WITH MINIMUM EXPENSE TO THE GOVERNMENT AND USERS FOR NEW EQUIPMENT.

RTOP NO. 125-06-10 TITLE: V/STOL AVIONICS SYSTEMS TECHNOLOGY  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: LIPTON, A. H. TEL. 617-494-2454  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP AND DEMONSTRATE THE AVIONICS SYSTEM TECHNOLOGIES THAT WOULD MAKE V/STOL AIRCRAFT ALL-WEATHER OPERATIONS BOTH TECHNICALLY AND ECONOMICALLY FEASIBLE ON CIVIL AIR ROUTE STRUCTURES AND IN AIR TRAFFIC ENVIRONMENTS REPRESENTATIVE OF THE 1975-1985 TIME PERIOD. ANALYSIS, SIMULATION AND FLIGHT DEMONSTRATION ARE COMBINED TO PROVIDE A DATA BASE FOR USE IN FUTURE V/STOL AVIONIC SYSTEM DESIGN EFFORTS. PHASE 1 OF THE WORK EVALUATED THE FEASIBILITY OF USING AN AIDED INERTIAL NAVIGATOR FOR TERMINAL GUIDANCE AND NAVIGATION OF V/STOL AIRCRAFT. PHASE 2 SEEKS TO EVALUATE INTEGRATED DIGITAL/STRAP-DOWN/NAVIGATION-AID SYSTEM CONCEPTS FOR FLIGHT CONTROL, GUIDANCE AND NAVIGATION OF V/STOL AIRCRAFT IN ALL FLIGHT REGIMES. PHASE 3 WILL CONSIDER THE APPLICATION OF RESULTS TO A COMMERCIALY FEASIBLE V/STOL AIRFRAME.

RTOP NO. 125-17-06 TITLE: NAVIGATION AND GUIDANCE SYSTEMS STUDIES  
AND PLANETARY LANDING TECHNOLOGY  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: NELSON, C. H. TEL. 703-827-3285  
TECHNICAL SUMMARY

PERFORM ANALYSIS OF NAVIGATION AND GUIDANCE WITH EMPHASIS ON THE RELATIVELY UNEXPLORED PROBLEMS OF MANNED EARTH ORBITAL AND LUNAR MISSIONS AND ADVANCED LANDING RADAR TECHNOLOGY FOR PLANETARY AND ALSO VTOL APPLICATIONS. COMPLETE LUNAR GRAVITATIONAL MODEL BASED ON ORBITER DATA FOR IMPROVING LUNAR SPACECRAFT ORBIT DETERMINATION, COMPLETE BESSEL SIDE BAND LANDING RADAR HELICOPTER FLIGHT TESTS, AND EVALUATE RESULTS FOR NEED OF ADDITIONAL EFFORT.

RTOP NO. 125-17-07 TITLE: EARTH ORIENTED ATTITUDE REFERENCE  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: NELSON, C. H. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS WORK IS TO DEVELOP SENSOR SYSTEMS FOR DETERMINING THE LOCAL VERTICAL AND THE POINTING DIRECTION OF INSTRUMENTATION FROM NEAR-EARTH SPACECRAFT. A COMPARISON OF CANDIDATE SYSTEMS IN EACH CATEGORY WILL BE MADE TO EVALUATE THEM FROM AN ACCURACY/OPERATIONAL FLEXIBILITY/COST VIEWPOINT. ADDITIONAL OBJECTIVES INCLUDE THE INVESTIGATION OF FACTORS WHICH LIMIT THE ACCURACY, RELIABILITY, OR OPERATIONAL FLEXIBILITY OF VARIOUS SENSOR SYSTEMS; AND RESEARCH TO DEFINE OR MINIMIZE THE EFFECTS OF SUCH FACTORS. CANDIDATE SYSTEMS INCLUDE HORIZON SENSORS, STAR TRACKERS OR MAPPERS, AND SUN SENSOR. THIS RESEARCH WILL PROVIDE BASIC INFORMATION TO DESIGN IMPROVED SENSING SYSTEMS FOR USE IN SATELLITES REQUIRING PRECISE ATTITUDE CONTROL OR POINTING KNOWLEDGE FOR METEOROLOGICAL, EARTH RESOURCES, OR COMMUNICATIONS APPLICATIONS.

RTOP NO. 125-17-08 TITLE: CLIMB, CRUISE, AND DESCENT CONTROL,  
GUIDANCE AND NAVIGATION OF SUPERSONIC  
AIRCRAFT

ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-2280  
TECHNICAL SUMMARY

AN ANALYTICAL STUDY HAS BEEN COMPLETED WHICH DERIVED A CONCEPT FOR COMBINING DOPPLER VELOCITY AND INERTIAL SENSED POSITION TO IMPROVE AIRCRAFT NAVIGATION PERFORMANCE. THE IMPROVEMENT ACHIEVABLE BY ALSO CONSIDERING EXTERNAL RADIO NAVIGATION AIDS WAS ALSO SHOWN. CURRENT ANALYTICAL STUDIES HAVE ESTABLISHED PERFORMANCE PARAMETERS FOR NAVIGATION CONCEPTS USING ONLY EXTERNAL RADIO NAVIGATION AIDS. BECAUSE THE INERTIAL GUIDANCE CONCEPT LOOKED PROMISING IN ANALYTICAL STUDIES, SYSTEMS BASED ON THEM ARE PROPOSED FOR NEXT-GENERATION AIRCRAFT OR SST GUIDANCE SYSTEMS. CURRENT STUDIES HAVE BEEN INITIATED TO PROVIDE A BETTER UNDERSTANDING OF PROBLEMS ASSOCIATED WITH MATHEMATICAL MODELS USED IN THE COMPUTATION SCHEMES AND THE ACTUAL PERFORMANCE ACHIEVED WITH HARDWARE. IN ADDITION, THE ANALYTICAL STUDY OF UTILIZATION OF RADIO AIDS WITHOUT THE INERTIAL NAVIGATOR IS CONTINUING. STUDIES ARE ALSO BEING MADE TO DERIVE OPTIMUM CLIMB TO CRUISE FLIGHT PATHS.

RTOP NO. 125-17-09 TITLE: TRANSITION, APPROACH AND LANDING GUIDANCE  
AND CONTROL SYSTEMS FOR V/STOL AIRCRAFT

ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-2280  
TECHNICAL SUMMARY

RESEARCH STUDIES AT AMES HAVE BEEN DIRECTED TO EXAMINE CONCEPTS FOR MORE PRECISE NAVIGATION OF V/STOL AIRCRAFT IN THE TERMINAL AREA AND TO STUDY METHODS OF PRESENTING THIS INFORMATION TO THE PILOT. ANALYTICAL AND SIMULATION STUDIES HAVE BEEN MADE OF THE PILOT'S ABILITY TO CONTROL VTOL AIRCRAFT. THE X-14 IS BEING MODIFIED TO BE A

FLIGHT TEST BED FOR FURTHER INVESTIGATIONS OF THIS PROBLEM. SIMULATION STUDIES HAVE DERIVED DISPLAY CONCEPTS WHICH APPEAR PROMISING FOR LOW VISIBILITY LANDINGS FOR STOL AIRCRAFT. THESE DISPLAY CONCEPTS UTILIZE A HEAD-UP TECHNIQUE TO KEEP THE PILOT IN THE CONTROL LOOP. THE CONVAIR 340 AIRCRAFT IS CURRENTLY INVOLVED IN IN-FLIGHT INVESTIGATIONS OF SOME OF THESE CONCEPTS.

RTOP NO. 125-17-10 TITLE: MANNED NAVIGATION, GUIDANCE AND CONTROL SYSTEMS (LAUNCH, MIDCOURSE, ABORT, AND ATMOSPHERIC ENTRY, SIMPLIFIED MANNED SPACE OPERATIONS)

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 45-961-2280

TECHNICAL SUMMARY

LIMITED ANALYTICAL STUDIES ARE CONTINUING TO DERIVE CONCEPTS FOR SIMPLIFIED ON-BOARD MANUAL CONTROL, GUIDANCE AND NAVIGATION OF SPACECRAFT IN NEAR-EARTH ORBIT. STUDIES OF MANUAL CONTROL, GUIDANCE AND NAVIGATION OF SPACECRAFT DURING LAUNCH AND REENTRY HAVE BEEN ESSENTIALLY COMPLETED. HOWEVER, THE CURRENT NASA STUDIES OF THE SPACE STATION AS ITS NEXT MISSION PROVIDES A NEED FOR A LOGISTICS RESUPPLY OR SHUTTLE VEHICLE FOR THIS MISSION. THIS LOGISTICS VEHICLE PROVIDES A NEED AND FOCUS FOR FURTHER RESEARCH IN MANNED CONTROL, GUIDANCE AND NAVIGATION SYSTEMS FOR THIS MISSION. PLANS ARE BEING FORMULATED FOR REDIRECTION OF THE ORBITAL STUDIES TO FOCUS ON THIS MISSION AND TO INITIATE SOME NEW STUDIES OF THE PROBLEM AREAS ASSOCIATED WITH THE REENTRY OF THE LOGISTICS VEHICLE WHICH IS REQUIRED FOR THIS MISSION.

RTOP NO. 125-17-11 TITLE: FLIGHT TEST AND OPERATIONS TECHNOLOGY

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: BURKE, M. E. TEL. 805-258-3311

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO EVALUATE AND ADVANCE FLIGHT TEST AND OPERATIONS TECHNOLOGY FOR SUPERSONIC AND HYPERSONIC AIRCRAFT GUIDANCE, AND CONTROL. THE SPECIFIC EFFORTS UNDERWAY AT THE PRESENT TIME INCLUDE THE DEVELOPMENT OF A REAL TIME FLIGHT PATH OPTIMIZATION PROGRAM AND ATTENDANT AIRCRAFT SYSTEM AND THE DEVELOPMENT OF VISUAL SIMULATION CAPABILITIES. APPLICATIONS OF THE RESULTS OF THIS EFFORT MAY APPLY TO ADVANCED SUPERSONIC TRANSPORT AND/OR MANEUVERING MILITARY AIRCRAFT.

RTOP NO. 125-17-12 TITLE: GIMBALLED INERTIAL SENSOR SUPPORTING DEVELOPMENT

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: ANDERSON, J. P. TEL. 617-494-2623

TECHNICAL SUMMARY

SURVEYS INDICATE THAT IT IS FEASIBLE TODAY TO DESIGN GYROSCOPES WITH DRIFT RATES LESS THAN .0001 DEGREES/HR. AS WELL AS SPECIFIC

FORCE RECEIVERS WITH BIAS STABILITY OF .5 MICRO-GEE OR BETTER. THESE CLASSES OF INSTRUMENTS WILL PERMIT 2 HOUR FLIGHTS OF SUPERSONIC AIRCRAFT TO SUCCESSFULLY INTERCEPT PRECISION LANDING AIDS SUCH AS ILS OR PAR WITHOUT ENROUTE EXTERNAL NAVIGATION AIDS TO THE INERTIAL NAVIGATOR. IN ADDITION, SATELLITE ORIENTATION ACCURACIES OF SEVERAL ARE SECONDS FOR PERIODS UP TO 30 DAYS CAN BE ACHIEVED. FINALLY, LONG MISSIONS UP TO TWO YEARS CAN BE PERFORMED AS THE EXPECTED LIFE EXPECTANCY OF THESE INSTRUMENTS WOULD FAR EXCEED THAT REQUIRED FOR A TWO-YEAR MISSION.

RTOP NO. 125-17-13 TITLE: GUIDANCE, NAVIGATION AND CONTROL SENSORS  
AND SYSTEMS STUDIES

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: WEDAN, R. W. TEL. 617-494-2467

TECHNICAL SUMMARY

TECHNOLOGY AND NEW CONCEPTS ARE REQUIRED FOR THE DESIGN OF INTEGRATED, ALL-DIGITAL GUIDANCE, NAVIGATION AND CONTROL SYSTEMS FOR MEETING REQUIREMENTS IMPOSED BY NASA'S FUTURE AERONAUTICAL AND ASTRONAUTICAL MISSIONS. NASA'S CONTINUED RESEARCH IN AIRCRAFT TECHNOLOGY WILL YIELD INCREASING CAPABILITY OVER THE SPEED SPECTRUM OVER THE NEXT DECADE. THE V/STOL AIRCRAFT REPRESENT THE LOW TO MEDIUM SPEED PORTION OF THIS SPECTRUM AND THE SST WILL ADVANCE CAPABILITIES AT THE UPPER END. TO PERMIT FULL UTILIZATION OF THE BASIC AIRCRAFT CAPABILITY, RESEARCH ON INTEGRATED GUIDANCE, NAVIGATION, AND CONTROLS MUST KEEP PACE WITH THE ENGINE AND AIRFRAME PROGRAMS. THIS BECOME PARTICULARLY IMPORTANT IN VIEW OF THE ADDED COMPLEXITY TO AIR TRAFFIC MANAGEMENT IN MEETING THE NEEDS SIMULTANEOUSLY OF AIRCRAFT RANGING FROM THE V/STOL TO THE SST.

RTOP NO. 125-17-14 TITLE: GUIDANCE SYSTEMS FOR ORBITAL OPERATIONS  
AND DOCKING

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: WEDAN, R. W. TEL. 205-453-1120

TECHNICAL SUMMARY

A COMPLETELY AUTOMATIC SYSTEM FOR RENDEZVOUS AND DOCKING OF ORBITAL SPACECRAFT WILL BE DEVELOPED. THIS RESEARCH PROGRAM WILL ENCOMPASS GUIDANCE THEORY, NUMERICAL COMPUTATION ALGORITHMS, RING LASER SYSTEMS, ATTITUDE CONTROL SYSTEMS AND INERTIAL INSTRUMENTS. OPTIMUM OR NEAR OPTIMUM GUIDANCE SYSTEMS FOR ORBITAL RENDEZVOUS WILL BE DEVELOPED AND EVALUATED THROUGH SIMULATION. THESE SYSTEMS WILL EMPLOY NUMERICAL PROCEDURES FOR COMPUTING OPTIMAL TRAJECTORIES WHICH ARE RELIABLE IN CONVERGENCE AND COMPUTATIONALLY FAST ENOUGH FOR REAL TIME APPLICATIONS. THE RESULTING GUIDANCE TECHNIQUES WILL BE EASILY IMPLEMENTED AND WILL NOT DEPEND UPON ENGINEERING APPROXIMATIONS OR EXPERIENCE FACTORS AS PRESENT METHODS DO.

RTOP NO. 125-17-15 TITLE: GUIDANCE AND CONTROL FOR CRUISING,  
ORBITING AND LANDING UNMANNED PLANETARY  
VEHICLES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE JPL PROGRAM IN GUIDANCE AND CONTROL FOR THE FUTURE, DERIVES FROM THE NEEDS OF FLYBY MISSIONS TO OUTER PLANETS AND THE NEED TO PLACE SOFISTICATED SCIENTIFIC PAYLOADS BOTH IN PLANETARY ORBIT, AND ON THE SURFACE. SUCH NEEDS INCLUDE: (1) GREATER ACCURACY IN NAVIGATION AND GUIDANCE FOR ORBIT INSERTION AND FOR OUTER PLANET FLYBYS; (2) METHODS OF CONTROLLING LARGE, FLEXIBLE VEHICLES; (3) HIGH RELIABILITY AND LONG LIFE IN SUBSYSTEMS AND COMPONENTS FOR MISSIONS OF LONG DURATION (10 TO 15 YEARS); (4) MORE EFFECTIVE STRATEGIES FOR MISSIONS REQUIRING MULTIPLE MANEUVERS. SPECIFIC AREAS OF WORK PROPOSED FOR FY70 FALL INTO THREE MAJOR AREAS. (I). GUIDANCE AND ATTITUDE-CONTROL-SYSTEM DESIGN. WE WILL DETERMINE THE FEASIBILITY OF AN APPROACH-GUIDANCE SYSTEM THAT USES ON-BOARD OPTICAL MEASUREMENTS OF PLANET AND SATELLITE POSITIONS FOR ACCURATE TRAJECTOR DETERMINATION. CONCURRENTLY, WE WILL PRODUCE A FUNCTIONAL DESIGN OF THE SOFTWARE NECESSARY FOR AN APPROACH-GUIDANCE SYSTEM REQUIRED FOR THE GRAND TOUR. WE WILL CONTINUE DEVELOPMENT OF TECHNIQUES TO DEFINE THE DYNAMIC INTERACTION OF LARGE FLEXIBLE APPENDAGES ON CONTROL SYSTEMS; THESE WILL BE APPLIED TO THE CONTROL SYSTEM FOR THE THERMO-ELECTRIC OUTER-PLANET SPACECRAFT (TOPS). DEVELOPMENT WILL CONTINUE ON AN OPTIMAL CONTROLLER FOR A SOFT LANDING SYSTEM. (II). MANEUVER STRATEGY AND NAVIGATION ANALYSIS. OUR OBJECTIVE WILL BE THE DEVELOPMENT OF MULTIPLE MANEUVER STRATEGIES AND IMPROVEMENT OF THE GUIDANCE SIMULATION PROGRAMS USED TO ESTABLISH MANEUVER STRATEGY. DEVELOPMENT OF TECHNIQUES FOR TRAJECTORY ANALYSIS WILL CONTINUE (III). SENSOR RESEARCH AND DEVELOPMENT. WE WILL CONTINUE EVALUATION OF NEW PHOTO-DETECTOR DESIGNS AND INITIATE DEVELOPMENT OF AN OPTICAL DIRECTION SENSOR THAT USES ELECTRO-OPTIC CRYSTALS IN PLACE OF AN IMAGE DISSECTOR. WE WILL COMPLETE VAN TESTING OF THE STRAPDOWN ELECTROSTATIC AEROSPACE NAVIGATION SYSTEM (SEAN) TO PROVE THE FEASIBILITY OF USING THE STRAPDOWN ELECTRICALLY SUSPENDED GYROSCOPE (ESG) AS THE BASIC POSITION SENSOR IN A NAVIGATION SYSTEM. USING KNOWLEDGE GAINED FROM THE SEAN PROGRAM, WE WILL ASSESS THE APPLICABILITY OF THE STRAPDOWN ESG FOR SPACECRAFT SYSTEMS.

RTOP NO. 125-17-17 TITLE: ADVANCED RESEARCH ON GUIDANCE & CONTROL  
SYSTEMS, COMPONENTS & TECHNIQUES

ORGANIZATION: NASA HEADQUARTERS

MONITOR: KANTER, J. TEL. 202-962-7294

TECHNICAL SUMMARY

THE EFFORTS TO BE SUPPORTED WILL BE CONCERNED WITH THE ADVANCEMENT IN THE STATE OF THE ART IN GUIDANCE AND CONTROL SYSTEMS, COMPONENTS AND ANALYTICAL TECHNIQUES FOR AEROSPACE MISSIONS. STUDIES ARE TO BE UNDERTAKEN TO DEVELOP MODELS FOR GUIDANCE PATHS WHICH ARE THE MOST ECONOMICAL IN TERMS OF VEHICLE PROPULSION (FUEL AND ENGINE SIZE) AND CONTROL SYSTEM FUNCTIONS (TAKING OF MEASUREMENTS, PROCESSING OF DATA, MIDCOURSE MANEUVERS, ETC.). GUIDANCE STUDIES

WILL BE INITIATED TO ANALYZE AIRCRAFT NAVIGATION REQUIREMENTS WITH THE INTENTION OF DEVELOPING NEW TECHNIQUES TO ACCOMMODATE THE RANGE OF TODAY'S AIRCRAFT PERFORMANCE. CONTROL SYSTEM STUDIES WILL INVESTIGATE CONCEPTS POTENTIALLY APPLICABLE TO THE AEROSPACE VEHICLE.

DESIGN TECHNIQUES WILL BE EXPLORED FOR THE ANALYSIS OF CONTROL AND GUIDANCE SYSTEM PERFORMANCE LEADING TO THE DEFINITION AND DEVELOPMENT OF HARDWARE. MATHEMATICAL TOOLS WILL BE DEVELOPED TO ANALYZE THE STABILITY OF HIGHER ORDER SYSTEMS. COMPONENTS FOR GUIDANCE AND CONTROL SYSTEMS, INCLUDING OPTICAL SUBSYSTEMS, WILL BE CONCEIVED, ANALYZED AND EVALUATED. ADVANCED STAR TRACKERS, STAR PATTERN RECOGNITION ELEMENTS, FLUIDIC, AND ELECTROMECHANICAL COMPONENTS ARE TYPICAL COMPONENTS. THE RESEARCH COVERED BY THIS RTOP WILL BE CONDUCTED AT UNIVERSITIES OR NONPROFIT RESEARCH CENTERS WITH NASA CENTERS PROVIDING TECHNICAL MONITORING ASSISTANCE.

RTOP NO. 125-17-18 TITLE: ALL-WEATHER INDEPENDENT LANDING MONITOR  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: DINEFF, J. TEL. 415-961-1111

TECHNICAL SUMMARY

A DISPLAY SYSTEM WILL BE DEVELOPED WHICH CAN BE PLACED IN THE COCKPIT OF AN AIRPLANE AND WILL PRESENT A VISUAL PICTURE OF THE RUNWAY AND ADJACENT TERRAIN THROUGH MICROWAVE SENSING DURING A LANDING APPROACH WHEN NORMAL VISIBILITY IS IMPAIRED. A STUDY WILL BE MADE TO DETERMINE WHETHER SUCH A SYSTEM COULD BE MADE TO WORK WITHOUT RELIANCE ON ACTIVE GROUND LANDING AIDS, BUT ONLY ON DIFFERENCES IN APPARENT TEMPERATURE OF TERRAIN AT MICROWAVE FREQUENCIES. CONSIDERATION WILL ALSO BE GIVEN TO THE DESIRABILITY OF AUGMENTING PERFORMANCE BY ACTIVE POINT SOURCES ALONG THE RUNWAY SUCH AS LOW COST MICROWAVE EMITTERS AND BY HIGH INTENSITY MU-WAVE FLOOD LIGHTS ILLUMINATING THE AIRPORT SCENE. RESEARCH WILL INCLUDE STUDIES OF HUMAN FACTORS SUCH AS THE SIZE OF THE VISUAL DISPLAY, THE FIELD OF VIEW OF THE MICROWAVE SYSTEM, IMAGE RESOLUTION AND UPDATE RATE, REQUIREMENT FOR COLLIMATION, HEAD-UP OR HEAD-DOWN DISPLAY, AND BEAM-SPLITTER VERSUS PANEL DISPLAY. FURTHER OBJECTIVES OF THIS RESEARCH WOULD BE TO CONSIDER SIMILAR SYSTEMS FOR COLLISION AVOIDANCE BY DETECTING THE APPROACH OF OTHER AIRPLANES WITH THE SAME ANTENNA SYSTEM AND VISUAL DISPLAY. IN A POSSIBLE FUTURE EXTENSION OF THE TECHNIQUE, RANGING COULD BE ACCOMPLISHED WITH A SIMILAR VISUAL AID BY USING TWO EMISSION FREQUENCIES FROM AN ACTIVE TRANSMITTER ON BOARD THE OTHER AIRCRAFT, ONE FREQUENCY OF WHICH WOULD BE THAT OF AN OXYGEN ABSORPTION FREQUENCY AND THE OTHER AT AN ADJACENT FREQUENCY LESS ATTENUATED BY MICROWAVES.

RTOP NO. 125-17-21 TITLE: OPTICAL RENDEZVOUS AND DOCKING SENSORS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: DINEFF, J. TEL. 205-453-1120

TECHNICAL SUMMARY

A COMPLETELY AUTOMATIC SYSTEM FOR RENDEZVOUS AND DOCKING OF ORBITAL SPACECRAFT WILL BE DEVELOPED. THIS RESEARCH PROGRAM WILL ENCOMPASS GUIDANCE AND RENDEZVOUS TECHNIQUES, SENSORS, AND OPTICAL



RADAR SYSTEMS. THE SPACE SHUTTLE VEHICLES AND MANNED SPACE STATIONS WILL REQUIRE A VERSATILE CAPABILITY FOR RENDEZVOUS AND DOCKING. THE GOAL OF THIS RESEARCH PROGRAM IS TO DEVELOP TECHNOLOGY REQUIRED TO PERFORM THESE ORBITAL OPERATIONS AUTOMATICALLY, EFFICIENTLY AND RELIABLY. FOR TERMINAL RENDEZVOUS AND DOCKING, AN OPTICAL RADAR SYSTEM WILL BE USED. THIS SYSTEM WILL FEATURE GIMBALLESS LASER TRACKING USING BEAM STEERING TECHNIQUES. THE DOCKING SCHEME WILL OPTIMALLY TRADEOFF FUEL REQUIREMENTS, TIME TO ACCOMPLISH DOCKING AND IMPULSE AT CONTACT.

RTOP NO. 125-17-22 TITLE: INVESTIGATION OF TERMINAL AREA  
NAVIGATION, GUIDANCE, AND DISPLAY CONCEPTS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: GEE, S. W. TEL. 805-258-3311

TECHNICAL SUMMARY

AN ANALYTICAL STUDY WILL BE CONDUCTED TO INVESTIGATE THE TERMINAL AREA GUIDANCE AND CONTROL LAWS TO PROVIDE AN IFR CIRCLING APPROACH CAPABILITY FOR A CANDIDATE CONFIGURATION OF A SPACE SHUTTLE VEHICLE. A COMPUTER SIMULATION USING THE VEHICLE EQUATIONS OF MOTION AND A COCKPIT WITH CHANGEABLE DISPLAYS WILL BE USED TO EVALUATE A GUIDANCE SCHEME AND PILOT WORKLOAD. THE SIMULATION RESULTS WILL BE VALIDATED BY FLIGHT TESTS OF THE GUIDANCE AND DISPLAY SYSTEMS IN AN F-104 IN LOW L/D CONFIGURATION. ADDITIONALLY, THE AVAILABLE INFORMATION ON ENERGY MANAGEMENT AND PREDICTIVE GUIDANCE TECHNIQUES WILL BE COMPILED INTO A SINGLE DOCUMENT.

RTOP NO. 125-17-33 TITLE: MANNED SPACE SHUTTLE: STUDY OF AUTOMATIC  
AND MANUAL TERMINAL GUIDANCE AND CONTROL

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-2280

TECHNICAL SUMMARY

CURRENT NASA STUDIES OF THE SPACE SHUTTLE VEHICLE INDICATE THAT RESEARCH IS NEEDED FOR MANNED CONTROL, GUIDANCE AND NAVIGATION FOR THE TERMINAL PHASE OF THE MISSION. A CONTRACT STUDY WILL BE INITIATED TO DEFINE LANDING APPROACH GUIDANCE CONCEPTS SUITABLE FOR MANUAL OR AUTOMATIC LANDINGS IN DAY, NIGHT, AND MARGINAL WEATHER CONDITIONS WITH SPECIFIC APPLICATION TO THE SPACE SHUTTLE VEHICLE. SIMULATION STUDIES WILL BE INITIATED TO: (A) INVESTIGATE THE ASTRONAUTS' ROLE IN THE LANDING APPROACH GUIDANCE SYSTEM; (B) INVESTIGATE PROBLEM AREAS ASSOCIATED WITH DEVELOPMENT OF PROMISING LANDING APPROACH GUIDANCE SYSTEM CONCEPTS AS DEFINED IN THE CONTRACT STUDY; AND (C) INVESTIGATE THE PILOTING PROBLEMS ASSOCIATED WITH TRANSITION OF AN AIRPLANE-LIKE ORBITER FROM A HIGH ANGLE OF ATTACK (APPROXIMATELY 60 DEGREES) TO A LOW ANGLE OF ATTACK IN THE LANDING APPROACH PHASE.



RTOP NO. 125-19-08 TITLE: AIRCRAFT FLIGHT CONTROL SYSTEMS AND  
COMPONENTS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

TO EVALUATE THE POTENTIAL AND IMPROVE THE BASIC UNDERSTANDING OF FLUIDIC DEVICES FOR PROVIDING RELIABLE, LOW COST FLIGHT CONTROL SYSTEMS FOR GENERAL AVIATION AIRCRAFT. TO EVALUATE AND DEVELOP DIGITAL CONTROL COMPONENTS AND TECHNIQUES FOR APPLICATION TO FUTURE AEROSPACE VEHICLES. TO APPLY THE THEORY OF NONLINEAR CONTROL SYSTEMS MORE EFFECTIVELY TO THE DESIGN OF AEROSPACE CONTROL SYSTEMS. THESE OBJECTIVES ARE TO BE MET BY EXPERIMENTATION WITH AND ANALYSIS OF FLUIDIC COMPONENTS AND DIGITAL SYSTEMS TO ESTABLISH IMPROVED CONCEPTS, AND BY THEORETICAL ANALYSES OF THE DESIGN OF CONTROL LOGICS BY VARIATIONAL METHODS. TO INCLUDE BOTH AIRCRAFT AND AEROSPACE APPLICATIONS.

RTOP NO. 125-19-09 TITLE: AVIONIC SUBSYSTEMS TECHNOLOGY

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

A TOTAL SYSTEMS CONCEPT FOR GENERAL AVIATION COCKPIT ELECTRONIC AIDS WHICH CONTRIBUTES TO FLIGHT SAFETY AND HAS A POTENTIAL FOR LOW-COST WILL BE INVESTIGATED, DEVELOPED, AND FLIGHT TESTED. ALSO, A TERMINAL AREA NAVIGATION SCHEME USING SPACECRAFT RANGING TECHNIQUES WILL BE INVESTIGATED FOR USE IN FLIGHT TESTING OF RESEARCH AIRCRAFT AND WILL BE STUDIED FOR APPLICATION TO AIRPORTS NOT EQUIPPED WITH ELECTRONIC LANDING AIDS. THE RESULTING INFORMATION ON THE TECHNIQUES WILL BE SUITABLE FOR INCORPORATION INTO THE DESIGN OF NEW EQUIPMENTS.

CONTINUING SUPPORT WILL BE PROVIDED DURING THE DEVELOPMENT PHASE OF THE DMS. THIS SUPPORT WILL BE PRINCIPALLY AIMED AT SOLVING UNEXPECTED PROBLEMS AS THEY ARE ENCOUNTERED. CONSEQUENTLY, TEST PROGRAMS TO BE ACCOMPLISHED ON THE DMS WHEN IT BECOMES OPERATIONAL ARE NOW BEING PREPARED. SPECIFIC TESTS WILL BE SELECTED JUST PRIOR TO THE OPERATIONAL DATE. THESE WILL INVOLVE A QUANTITATIVE EVALUATION OF VARIOUS DISPLAY REQUIREMENTS AND CONFIGURATIONS, GUIDANCE, CONTROL, AND STABILITY AUGMENTATION DEVICES, AND OTHER ELECTRONIC SUBSYSTEMS DESIGNED TO AID THE PILOT AND/OR REDUCE THIS WORK LOAD DURING CRITICAL PHASES OF FLIGHT, SUCH AS MECHANISMS TO CONTROL WING SWEEP, BOUNDARY LAYER, THRUST REVERSAL, ETC. LANGLEY IS REORIENTING ITS ELECTRONICS RESEARCH PROGRAM TO FURTHER EMPHASIZE THOSE ACTIVITIES PERTAINING TO AVIONICS AND AIRCRAFT FLIGHT INSTRUMENTATION. SEVERAL STUDY GROUPS HAVE RECENTLY BEEN ESTABLISHED WITH THE OBJECTIVES OF DEFINING SPECIFIC RESEARCH NEEDS AND RECOMMENDING APPROACHES TO THESE PROBLEMS. THE ANTICIPATED INCREASE IN ACTIVITY IN THIS AREA IS REFLECTED IN THE ESTIMATES PROVIDED FOR F.Y. 1971 AND F.Y. 1972.

RTOP NO. 125-19-10 TITLE: CONTROL AND STABILIZATION SYSTEMS FOR  
MANNED ORBITING SPACECRAFT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THIS WORK WILL GENERATE THE CONTROL AND STABILIZATION TECHNOLOGY FOR LARGE MANNED SPACECRAFT WITH LONG-DURATION MISSIONS. BOTH SPACECRAFT AND ONBOARD EXPERIMENT PLATFORM CONTROL SYSTEMS WILL BE INVESTIGATED. THE COMBINED POINTING CONTROL ACCURACY OBJECTIVE IS 0.01 ARC SECOND. COMPUTER SIMULATIONS OF FLEXIBLE, MULTIMODULE SPACECRAFT WILL BE USED TO ESTABLISH STABILIZATION SYSTEM AND COMPONENT REQUIREMENTS FOR ANTICIPATED DISTURBANCE AND MISSION PROFILES. PROTOTYPE SPACECRAFT AND EXPERIMENT CONTROL HARDWARE WILL BE DEVELOPED AND EVALUATED DURING REAL-TIME, DIGITAL-HARDWARE SIMULATIONS OF ACQUISITION, FINE POINTING, AND MANEUVER TASKS. PRIMARY PROBLEMS INCLUDE THE EXTENSION OF ACTUATOR AND CONTROL SYSTEM BAND WIDTH AND THE ELIMINATION OF HARDWARE LIMIT CYCLES WHICH RESULT IN INTOLERABLE WEAR AND PERFORMANCE DEGRADATION FOR THE HIGH-POINTING-ACCURACY APPLICATIONS. IMPROVED ACTUATORS, SUCH AS A SECOND-GENERATION CONTROL MOMENT GYRO PROTOTYPE FOR THE MANNED SPACE STATION, WILL BE IMPLEMENTED AND TESTED, AND FLIGHT HARDWARE SPECIFICATIONS FOR THE ATTITUDE CONTROL SYSTEM OF A MANNED SPACE STATION AND SPACE BASE WILL BE DERIVED. APOLLO TELESCOPE MOUNT TECHNOLOGY WILL BE EXTENDED TO STELLAR AND GALACTIC ASTRONOMY, AND ATTACHED VERSUS DETACHED EXPERIMENT OPERATION WILL BE ANALYZED. EXPERIMENT ISOLATION AND CONTROL SIMULATIONS WITH SCALED AND FULL-SCALE HARDWARE WILL BE EMPLOYED TO DEFINE THE POINTING ACCURACIES ATTAINABLE FOR EXPERIMENT MODULES DURING ATTACHED AND DETACHED OPERATION. RESULTS OF THIS WORK ARE DIRECTLY APPLICABLE TO A MANNED SPACE STATION OR SPACE BASE, TO THE DRY WORKSHOP AND ATM PROGRAMS, AND TO ASTRONOMY AND EARTH RESOURCE EXPERIMENTS. LANGLEY EXPERIENCE IN DEFINING AND EVALUATING THE PRIMARY SPACECRAFT CONTROL SYSTEM CONFIGURATION FOR THE APOLLO TELESCOPE MOUNT CLUSTER HAS SHOWN THAT CURRENT SPACECRAFT AND EXPERIMENT STABILIZATION SYSTEM TECHNOLOGY IS INADEQUATE FOR HIGH-ACCURACY (0.01 ARC SECOND) OR LONG-TERM MANNED MISSIONS,----

RTOP NO. 125-19-11 TITLE: MANUAL AND AUTOMATIC FLIGHT CONTROL  
SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

STUDIES WILL BE PERFORMED TO DEFINE MANUAL CONTROL TECHNIQUES AND PROCEDURES UTILIZING VISUAL AND MOTION SIMULATORS. THE MANNED SPACE MISSIONS WILL INCLUDE MISSIONS SUCH AS BOOST ABORT, RENDEZVOUS AND DOCKING, LUNAR APPROACH AND LANDING AND ATMOSPHERIC RE-ENTRY. AIRCRAFT OPERATIONS WILL INCLUDE ADVANCED AIRCRAFT PRECISION APPROACHES AND LANDING AND CONTROL REQUIREMENTS IN TURBULENT AIR. BASIC GUIDANCE, CONTROL, AND PROPULSION SYSTEM REQUIREMENTS AND PILOT ABILITY TO PERFORM MANUAL CONTROL FUNCTION WILL BE ESTABLISHED. STUDIES WILL ALSO BE PERFORMED TO DEVELOP TECHNIQUES IN ELECTRONICS AND OPTICS FOR THE GENERATION OF VISUAL CUES FOR APPLICATION TO

SIMULATIONS USED FOR CONTROL AND DISPLAY SYSTEM RESEARCH AND DEVELOPMENT. AIRCRAFT SIMULATIONS WILL BE PERFORMED TO EVALUATE MANUAL AND AUTOMATIC CONTROL REQUIREMENTS OF ADVANCED AIRCRAFT. THESE STUDIES WILL ALSO CONSIDER AIRCRAFT SINGLE AND MULTI-AXIS DAMPER REQUIREMENTS AND PILOT EVALUATIONS OF FLYING QUALITIES. STUDIES WILL BE CONDUCTED TO DEFINE THE REQUIREMENTS FOR RESEARCH AND TRAINING SIMULATOR VISUAL DISPLAYS. HUMAN PERFORMANCE TEST MEASURES AND EQUIPMENT WILL BE DESIGNED AND IMPLEMENTED TO PROVIDE A MEASURE OF MEASURING PILOT LEARNING, DECISION PROCESSES AND PSYCHOMOTOR SKILL TO AID IN FUTURE SYSTEM DESIGN.

RTOP NO. 125-19-12 TITLE: SPACECRAFT (UNMANNED) LOGIC AND ATTITUDE CONTROL SYSTEMS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-2280

TECHNICAL SUMMARY

STABILIZATION AND CONTROL OF UNMANNED SATELLITES HAS BEEN DEMONSTRATED IN SPACE FLIGHTS OF ACTIVELY AND PASSIVELY STABILIZED VEHICLES. PRESENT PROBLEM AREAS UNDER STUDY AT AMES ARE PRECISENESS OF CONTROL OVER LARGE ANGLES AND ACQUISITION AND REACQUISITION CONCEPTS FOR ACTIVE STABILIZATION FOR INERTIALLY STABILIZED AND EARTH-POINTING VEHICLES; AND PREDICTION OF MOTION FOR PASSIVELY STABILIZED VEHICLES TO INCREASE PRECISENESS OF DATA RECEIVED FROM SCANNING DATA SOURCES. SEVERAL ADVANCED SENSOR AND SYSTEM

DEVELOPMENT PROGRAMS ARE UNDERWAY. THESE CONSIST OF 1) A SOLAR ASPECT SENSOR FOR EXPERIMENT ALIGNMENT, 2) A FLUIDIC CONTROL SYSTEM, AND 3) A HYDRAZINE REACTION JET THRUSTER SYSTEM. OTHER DEVELOPMENTS:

SUCH AS 1) A SOLID-STATE HORIZON SENSOR WHICH PROVIDES ATTITUDE INFORMATION, 2) A LIGHT-WEIGHT TV CAMERA SUITABLE FOR SOLAR VIEWING, AND 3) AN ADAPTIVE PNEUMATIC ATTITUDE CONTROL SYSTEM; ARE IN THE CONCEPTUAL STAGES OF DEVELOPMENT.

RTOP NO. 125-19-13 TITLE: MANNED FLIGHT CONTROL SYSTEMS THEORY AND TECHNOLOGY

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-1111

TECHNICAL SUMMARY

RESEARCH IS BEING CONDUCTED TO DESCRIBE AND PREDICT HUMAN CAPABILITIES IN OPERATING MANNED CONTROL SYSTEMS. THE ANALYTIC TECHNIQUES OF SERVO-SYSTEMS ANALYSIS AND INFORMATION THEORY, INTERACTIVE WITH THE RESULTS OF EXPERIMENTS CONDUCTED WITH HUMAN SUBJECTS, ARE BEING UTILIZED TO MODEL HUMAN BEHAVIOR AND TO DETERMINE LIMITATIONS IN HUMAN CAPACITY FOR PERFORMANCE. THE RESULTS OF THESE EFFORTS HAVE BEEN THE PRODUCTION OF TECHNIQUES AND A BODY OF KNOWLEDGE USEFUL IN DETERMINING OPTIMAL INFORMATION DISPLAY-PILOT-VEHICLE-CONTROL INTERFACING, AS WELL AS MAKING ANALYTICAL AIRCRAFT HANDLING QUALITY EVALUATIONS FEASIBLE. THE RESULTS OF CURRENT EFFORTS WILL EXTEND THESE TECHNIQUES AND KNOWLEDGE TO INCLUDE THE PREDICTION OF WORKLOAD AND THE OPTIMIZATION OF HUMAN PERFORMANCE IN MULTI-DIMENSIONED TASKS SUCH AS AN AIRCRAFT APPROACH

AND LANDING TASK. OUT-THE-WINDOW VISUAL SIMULATION STUDIES ARE CURRENTLY BEING CONDUCTED TO EXTEND THE FIELD OF VIEW OF EXISTING VISUAL SIMULATION EQUIPMENT. THESE STUDIES ARE BASED ON THE USE OF FLYING SPOT SCANNER IMAGE-GENERATION EQUIPMENT TO DETERMINE IF SUCH EQUIPMENT CAN BEST EXTEND THE RANGE IN ALTITUDE AND TRANSLATIONAL DISTANCE IN FIELD OF VIEW.

RTOP NO. 125-19-14 TITLE: GENERAL AVIATION FLIGHT CONTROL SYSTEMS AND DISPLAYS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: BURKE, M. E. TEL. 805-258-3311

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO PROVIDE AVIONIC SYSTEM TECHNOLOGY, DEVELOPMENT AND CRITERIA THAT WILL CONTINUE THE IMPROVEMENTS IN SAFETY AND UTILITY OF GENERAL AVIATION AIRCRAFT. VARIOUS NEW CONCEPTS IN FLIGHT CONTROL AND DISPLAY SYSTEMS ARE BEING INVESTIGATED THROUGH THE USE OF SIMULATORS AND FLIGHT VEHICLES THAT WILL EVENTUALLY PERMIT COMPLETELY AUTOMATIC FLIGHT THROUGH AIRBORNE AND GROUND CONTROL COMPUTER PROGRAMMING.

RTOP NO. 125-19-16 TITLE: RESEARCH IN FLIGHT DISPLAY MEDIA

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: HILBORN, E. TEL. 617-494-2368

TECHNICAL SUMMARY

OBJECTIVES: MODERN AEROSPACE VEHICLES ARE PLACING NEW REQUIREMENTS ON VISUAL DISPLAY MEDIA. CONVENTIONAL MULTI-INSTRUMENT DISPLAYS WITH THEIR NUMEROUS DIALS, TAPES, ETC. ARE INADEQUATE IN RELIABILITY, SIZE, AND FLEXIBILITY. THE INTRODUCTION OF COMPUTER MAKES THE DEVELOPMENT OF MULTI-FORMAT DIGITALLY DRIVEN DISPLAYS, SUCH AS CRT'S, PLASMA-MATRICES, EL MATRICES, OF MAJOR IMPORTANCE. APPLICATIONS: SPACE VEHICLE AND AIRCRAFT COCKPIT DISPLAYS; SPACE BASE AND SPACE SHUTTLE DISPLAY CONSOLES. APPROACH: DEVELOPMENT WILL BE CARRIED ON IN THREE AREAS: (1) COMPUTER PROGRAMMING AND CHARACTER GENERATORS, (2) DISPLAY DEVICES, AND (3) DISPLAY-PILOT-VEHICLE DYNAMICS. THE DEVICES AND SYSTEMS PRODUCED WILL BE CARRIED THROUGH FLIGHT TEST WITH AMES RESEARCH CENTER.

RTOP NO. 125-19-17 TITLE: ADVANCED CONTROL COMPONENTS FOR ORBITING SPACECRAFT

ORGANIZATION: GODDARD SPACE FLT. CTR.

MONITOR: EVANS, H. E. TEL. 301-982-5194

TECHNICAL SUMMARY

RESEARCH, DESIGN AND EVALUATION OF NEW COMPONENT AND RELATED CONTROL CIRCUITRY ARE CONDUCTED. INCLUDED ARE IMPROVEMENTS IN LIFETIME AND PERFORMANCE CHARACTERISTICS THROUGH ADVANCED COMPONENT TECHNOLOGY. COMPONENT TECHNOLOGY ADVANCEMENTS INCLUDE THE TECHNICAL BREAKDOWN IN THE AREA OF ELECTRONIC COMMUTATION. THIS MOTOR CONCEPT IS INTEGRATED INTO CONTROL ACTUATOR DESIGNS SUCH AS PRIME MOVERS FOR

GYRO GIMBALS, SPACECRAFT ANTENNAS AND OTHER SIMILAR COMPONENTS REQUIRING RELIABLE AND PRECISION PERFORMANCE. SPEED AND POSITION CONTROL ELECTRONICS COMPATIBLE WITH THIS NEW CONCEPT WILL ALSO BE DEVELOPED. ADVANCED MOTOR DESIGNS TO ELIMINATE OR MINIMIZE WEAROUT PRONE PARTS SUCH AS BEARINGS WILL BE INVESTIGATED. BRUSHLESS MOTOR DESIGN WILL BE EXTENDED INTO THE MULTI-HORSEPOWER RANGE. FLIGHT TESTING, WHERE APPROPRIATE FOR CORRELATION OF GROUND TEST DATA, WILL BE CONDUCTED.

RTOP NO. 125-19-18 TITLE: GUIDANCE AND CONTROL RESEARCH FOR  
PLANETARY ROVING VEHICLES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE WORK OF THIS PROGRAM IS NECESSARY TO MEET THE NEEDS OF PLANETARY EXPLORATION PROGRAMS BEYOND THE ORBITER PHASE THAT SEEK TO OBTAIN DIRECT SCIENTIFIC INFORMATION ABOUT PLANETARY SURFACES. THE LONG RANGE OBJECTIVE IS TO INVESTIGATE THE REQUIREMENTS AND DEVELOP THE TECHNIQUES AND TECHNOLOGY FOR THE GUIDANCE AND CONTROL OF PLANETARY SURFACE SYSTEMS, INCLUDING UNMANNED PLANETARY ROVING VEHICLES CAPABLE OF OPERATING OVER A RANGE OF 1000 MILES FROM THE LANDING SITE. THE TECHNOLOGY SHOULD BE DEVELOPED FOR THE POST VIKING (ORBITER/LANDER) PERIOD STARTING AROUND 1974. COMMUNICATION DISTANCES TO THE PLANETS REQUIRE THAT ROVING VEHICLES BE CAPABLE OF AUTOMATIC OBSTACLE AVOIDANCE AND NAVIGATION WITH A MINIMUM USE OF GROUND COMMAND. PAYLOAD RESTRICTIONS DEMAND SIGNIFICANT REDUCTIONS IN WEIGHT AND POWER. FOR FY70, PRIORITY IS GIVEN TO (1) THE DEVELOPMENT OF ADVANCED ELECTRO-OPTICAL SENSORS FOR OBSTACLE AVOIDANCE, (2) AUTOMATIC ROVING VEHICLE COMPUTER DEVELOPMENT, AND (3) DEVELOPMENT OF A MINIMUM ENERGY CONTROLLER FOR A VEHICLE DRIVE SYSTEM. THE SENSOR AND COMPUTER WORK IS ESSENTIAL TO THE REQUIREMENT THAT A VEHICLE AVOID OBSTACLES AND NAVIGATE OVER A 1000 MILE RANGE. THE MINIMUM ENERGY CONTROLLER IS ESSENTIAL TO MINIMIZING POWER USAGE, AND MAY HAVE INDUSTRIAL APPLICATION AS WELL.

RTOP NO. 125-19-19 TITLE: ANTENNA/TELESCOPE CONTROL SYSTEMS

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: WINSTON, G. C. TEL. 301-982-5626

TECHNICAL SUMMARY

NEW CONTROL SYSTEM CONCEPTS AND DESIGN METHODS WILL BE RESEARCHED, DESIGNED AND EVALUATED DIGITAL COMPUTER PROGRAMS AND TECHNIQUES FOR THE SIMULTANEOUS AND COORDINATED CONTROL OF A GROUP OF COOPERATIVE OPTICAL TRACKING MOUNTS WILL BE DEVELOPED. OPTIMAL AND ADAPTIVE METHODS WILL BE APPLIED TO THE CONTROL SYSTEMS OF STEERABLE RF AND OPTICAL TRACKING DEVICES AND PLANT IDENTIFICATION PROCEDURES DEVELOPED TO PERMIT THE EFFECTIVE USE OF SUCH METHODS. RECENT ADVANCES IN MODERN CONTROL THEORY WILL BE TRANSLATED INTO PRACTICAL DESIGN PROCEDURES. THESE PROCEDURES ARE TO BE CAPABLE OF PRODUCING SYSTEM DESIGNS WHICH MEET PRESENT AND FUTURE REQUIREMENTS OF NARROW BEAM LASER OPTICAL SYSTEMS AND MILLIMETER WAVE ANTENNAS, I.E.,

FRACTIONAL ARC SECOND ACCURACY FOR OPTICAL SYSTEMS. EMPHASIS WILL BE PLACED UPON THE USE OF DIGITAL CONTROL TECHNIQUES AND THE DEVELOPMENT OF COMPUTER-AIDED DESIGN METHODS. COMPUTER-AIDED DESIGN SOFTWARE AND THE PROCEDURES FOR ITS USE WILL BE MODULAR TO PERMIT INCLUSION OF NEW METHODS AND EXTENSION TO ADDITIONAL REQUIREMENTS AS THEY APPEAR.

RTOP NO. 125-19-20 TITLE: APPLICATION OF CONTROL AND GUIDANCE  
THEORY AND MATHEMATICAL MODELING  
TECHNIQUES TO AIRCRAFT SYSTEMS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

TECHNICAL SUMMARY

SEVERAL CONTRACT STUDIES HAVE BEEN DIRECTED TO PROBLEMS OF OBSERVABILITY AND CONTROLLABILITY AND TO EXAMINING EXISTING THEORIES OF GUIDANCE AND CONTROL SUCH AS KALMAN, LYAPUNOV, AND PONTRYAGIN TO INCREASE THE GENERAL APPLICABILITY OF LINEAR THEORY TO ACTUAL SYSTEMS WHICH ARE NONLINEAR. THESE STUDIES HAVE MET WITH SOME SUCCESS BOTH IN OBTAINING LINEAR APPROXIMATIONS AND IN USE OF THE DIGITAL COMPUTER TO REITERATE FOR THE SOLUTION. MATHEMATICAL MODELING OF HUMAN RESPONSE CHARACTERISTICS HAS BEEN SUCCESSFUL IN DERIVING TRANSFER FUNCTIONS OR PILOT-DESCRIBING FUNCTIONS FOR SIMPLE SINGLE-AXIS TRACKING TASKS FOR PRESCRIBED INPUTS. THIS WORK HAS BEEN EXTENDED TO THE DETERMINATION OF PILOT DESCRIBING FUNCTIONS FOR SIMPLE TASKS FROM ACTUAL FLIGHT RECORDS. THIS EXTENSION INCLUDE A METHOD OF DERIVING A MODEL OF THE SYSTEM BEING OPERATED BY THE PILOT. IN ADDITION, THE KALMAN STATISTICAL APPROACH AND COMPUTATIONAL TECHNIQUES SUCH AS THE NEWTON RAPHSON METHOD HAVE BEEN USED WITH SOME SUCCESS IN THE IDENTIFICATION OF SYSTEM TRANSFER FUNCTIONS AND PARAMETERS.

RTOP NO. 125-19-20 TITLE: HUMAN OPERATOR CHARACTERISTICS IN MANNED  
FLIGHT CONTROL SYSTEMS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: GOOLSBY, L. D. TEL. 202-962-7254

TECHNICAL SUMMARY

RESEARCH IN THIS AREA IS DIRECTED TOWARDS OPTIMIZING MAN'S ROLE IN OPERATING AND CONTROLLING AIRCRAFT. IT INVOLVES THE FORMULATION AND DEVELOPMENT OF THE ANALYTICAL TOOLS REQUIRED FOR THE NUMEROUS AND COMPLEX TRADEOFF AND EVALUATION STUDIES INVOLVED IN THE DESIGN OF AN ADVANCED MANNED FLIGHT CONTROL SYSTEM. THE PROGRAM COVERS THE FOLLOWING AREAS: DESCRIBING FUNCTION MODELS, DECISION PROCESSES, DISPLAYS, COMPUTER PROCESSING OF MANUAL CONTROL RECORDS, CONTROLLED ELEMENTS, PHYSIOLOGICAL MODELING, ADVANCED MODELING TECHNIQUES, AND APPLICATION OF MANUAL CONTROL THEORY TO FLIGHT CONTROL PROBLEMS. MAJOR EMPHASIS IS PLACED ON MODELING THE DECISIONS WHICH HUMAN CONTROLLERS FACE IN MANUAL CONTROL SITUATIONS AND ON EXAMINATION OF THE DYNAMIC PROCESSES OCCURRING WITHIN THE VISUAL, VESTIBULAR, AND NEUROMUSCULAR SYSTEMS OF THE HUMAN OPERATOR IN A MANUAL CONTROL TASK.

THOSE TASKS WHERE SIMPLE, NEARLY CONTINUOUS CONTROL BEHAVIOR IS POSSIBLE CAN BE ADEQUATELY DESCRIBED BY MEAN OF QUASI-LINEAR DESCRIBING FUNCTIONS. HOWEVER, MUCH MORE NEEDS TO BE LEARNED ABOUT



SITUATIONS IN WHICH THE HUMAN OPERATORS OF COMPLEX SYSTEMS ARE FACED WITH HIERARCHIES OF DECISIONS AND WHERE THEIR CONTROL ACTIONS ARE DISCRETE RATHER THAN CONTINUOUS. THIS PROGRESS IS BEING CARRIED OUT THROUGH GRANTS AND CONTRACTS WITH M.I.T., UNIVERSITY OF SOUTHERN CALIFORNIA, AND UNIVERSITY OF MICHIGAN.

RTOP NO. 125-19-22 TITLE: ADVANCED AEROSPACE CONTROL THEORY AND APPLICATIONS

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: SHUCK, O. H. TEL. 617-494-2355

TECHNICAL SUMMARY

WORK IS BEING PERFORMED IN A BROAD AREA OF AUTOMATIC AND MANUAL CONTROL THEORY AND APPLICATION. DEVELOPMENTS IN STABILIZATION OF CONTROL SYSTEMS, HANDLING OF RANDOM DISTURBANCES EITHER EXTERNALLY ACTING OR INTERNALLY GENERATED, OPTIMIZATION OF SYSTEM PERFORMANCE, DECOUPLING TECHNIQUES FOR MULTIVARIABLE SYSTEMS, CONTROL OF DISTRIBUTED PARAMETER SYSTEMS, AND HUMAN CONTROL AND MONITORING OF COMPLEX AEROSPACE SYSTEMS FORM THE BASIC PROGRAM OF RESEARCH IN THIS AREA. THEY ARE BEING STUDIED AND DEVELOPMENTS ARE BEING MADE BASED ON MODERN CONTROL THEORETIC CONCEPTS. COMPUTER SIMULATIONS TO DEMONSTRATE THE FEASIBILITY OF NEW APPROACHES ARE BEING UNDERTAKEN. RESULTS OF THE RESEARCH ARE REPORTED IN NASA PUBLICATIONS, TECHNICAL JOURNALS, AND IN PRESENTATIONS AT LEADING TECHNICAL CONFERENCES. THIS WORK IS BEING DONE SO AS TO PROVIDE THE NECESSARY ADVANCED TECHNIQUES FOR A LARGE VARIETY OF AEROSPACE CONTROL PROBLEMS IN A FIVE YEAR TIME FRAME INCLUDING ATC, V/STOL, SST AND GENERAL AVIATION; MANNED AND COMMANDED SPACECRAFT AND LAUNCH BOOSTERS.

RTOP NO. 125-19-23 TITLE: LOAD RELIEF AND GUST ALLEVIATION CONTROL SYSTEM TECHNOLOGY FOR ILRV SPACE VEHICLES

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: SHUCK, O. H. TEL. 205-453-1120

TECHNICAL SUMMARY

THE REQUIREMENT FOR THE DELIVERY OF A LARGE PAYLOAD INTO ORBIT BY A LOW-COST REUSEABLE SPACE VEHICLE, AT ANY TIME (HIGH WINDS, BAD WEATHER CONDITIONS), AND RETURN BOTH BOOSTER AND ORBITER IN O/O LANDING CONDITIONS DICTATES THAT STRUCTURAL LOADING AND CYCLIC LOADING (FATIGUE) BE KEPT TO A MINIMUM. THE DESIGN OF THIS LOAD ALLEVIATION CONTROL SYSTEM IS COMPLICATED BY VARIOUS MISSION REQUIREMENTS, PIGGY-BACK STRUCTURES, UNSYMMETRICAL DYNAMICS AND STRUCTURAL COUPLING AND LARGE AERODYNAMIC SURFACES. STRONG COUPLING BETWEEN GUIDANCE AND CONTROL DURING THE LANDING PHASE ADDS ADDITIONAL COMPLEXITY. TWO BASIC TECHNICAL AREAS TO BE STUDIED IN THE CONTROL SYSTEM ARE: (1) REDUCTION OF MEAN WIND SPEED STRUCTURAL LOADS (LOAD REDUCTION) (2) GUST ALLEVIATION (BENDING MODE SUPPRESSION). THE STUDY WOULD DEVELOP THE CONTROL LOGIC TO MEET THE LOAD REDUCTION AND GUST ALLEVIATION REQUIREMENTS OF TYPICAL ILRV SPACE VEHICLE AND INTEGRATE IT INTO A TYPICAL SYSTEM.



RTOP NO. 125-19-36 TITLE: EARTH ORBIT LOGISTICS - GUIDANCE,  
NAVIGATION, AND CONTROL

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: KENNEDY, R. C. TEL. 713-483-4296

TECHNICAL SUMMARY

OBJECTIVE: ATMOSPHERIC DISTURBANCES MAY EXCITE STRUCTURAL MODES WHICH CAN COMPROMISE STRUCTURAL LIFE, HANDLING QUALITIES AND CONTROLLABILITY. THE OBJECTIVE OF THIS EFFORT IS TO DETERMINE IF A REQUIREMENT EXISTS FOR A LOAD ALLEVIATION SYSTEM FOR BOTH THE ORBITER AND BOOSTER DURING LAUNCH, ENTRY AND RECOVERY. IF SUCH A REQUIREMENT IS IDENTIFIED, A PRELIMINARY DEFINITION OF THE REQUIRED LOAD ALLEVIATION SYSTEM WILL BE FORMULATED.

RTOP NO. 125-21-04 TITLE: ENTRY COMMUNICATIONS AND TRACKING

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE BASIC OBJECTIVE IS TO DEVELOP ADVANCED COMMUNICATION TECHNIQUES AND EQUIPMENTS REQUIRED FOR FUTURE LANGLEY PROGRAMS, SUCH AS: PLANETARY LANDERS AND ORBITING RELAYS, ADVANCED METEOROID SATELLITES, MANNED SPACE STATIONS AND LOGISTIC SUPPORT VEHICLES, AND VARIOUS FLIGHT RESEARCH PROGRAMS. A RESEARCH PROGRAM WILL BE CONDUCTED TO DEVELOP THE KNOWLEDGE REQUIRED TO PREDICT COMMUNICATIONS AND TRACKING SYSTEMS PERFORMANCE DURING SPACECRAFT ENTRY INTO EARTH AND OTHER PLANETARY ATMOSPHERES AND TO DEVELOP TECHNIQUES TO IMPROVE RADIO PROPAGATION THROUGH ENTRY PLASMAS. THE CAPABILITY TO ACCURATELY PREDICT COMMUNICATION PERFORMANCE IN AN ENTRY ENVIRONMENT IS REQUIRED FOR SYSTEMS DESIGN (POWER, FREQUENCY, DATA RATES, ETC.), LOCATION OF TRACKING EQUIPMENT (APOLLO TRACKING SHIPS), AND TO PROVIDE MEANS OF DATA ACQUISITION DURING THE BLACKOUT (VIKING). ALSO RESEARCH WILL BE CONDUCTED TO DEVELOP NEW ANALYTICAL TECHNIQUES FOR PREDICTING THE PERFORMANCE OF SPACECRAFT ANTENNAS IN A PLASMA ENVIRONMENT. LABORATORY AND THEORETICAL INVESTIGATIONS OF SUPERCONDUCTING THIN FILM JUNCTIONS WILL BE CONDUCTED IN ORDER TO DEVELOP PRACTICAL COMMUNICATION EQUIPMENTS, USING THESE JUNCTIONS. DURING FY-70, THE MAIN EFFORT WILL BE AN INVESTIGATION AND CALIBRATION OF PLASMA DIAGNOSTIC ANTENNAS AND LANGMUIR PROBES IN AN INHOMOGENEOUS PLASMA FLOW FIELD; AN EVALUATION OF THE EFFECTIVENESS OF FOUR ELECTROPHILIC MATERIALS IN REDUCING SIGNAL ATTENUATION IN PLASMAS; AND THE DEVELOPMENT OF INSTRUMENTATION FOR PLASMA DIAGNOSTICS AND HIGH FREQUENCY (X-BAND) COMMUNICATIONS SYSTEMS. RECENTLY DEVELOPED DIFFRACTION THEORY TECHNIQUES FOR ANTENNA PATTERN PREDICTION WILL BE COMBINED WITH COMPUTER PROGRAMS THAT HAVE BEEN DEVELOPED TO DESCRIBE THE IMPEDANCE OF VARIOUS ANTENNA RADIATING INTO A DIELECTRIC MEDIA. THE FEASIBILITY OF UTILIZING SUPERCONDUCTING, THIN FILM TUNNELING JUNCTIONS AS LOW NOISE AMPLIFIERS AND AS PASSIVE ELEMENTS AT EXTREMELY HIGH FREQUENCIES WILL BE INVESTIGATED.

RTOP NO. 125-21-05 TITLE: PILOT WARNING AND COLLISION AVOIDANCE  
SYSTEM RESEARCH

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3825

TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS WORK IS THE DEVELOPMENT OF TECHNIQUES WHICH ARE SUITABLE FOR USE BY GENERAL AVIATION AS WELL AS THE AIR CARRIERS FOR THE DETECTION AND PILOT WARNING OF IMPENDING MID-AIR ENCOUNTERS. PRESENT ESTIMATES OF THE NUMBER OF NEAR MISSES IN THE UNITED STATES ARE ON THE ORDER OF 500 TO 1,000 A YEAR. INDICATIONS ARE THAT THE MAJOR PORTION OF THE PILOT WORKLOAD, AFTER DESCENT FROM CRUISE ALTITUDE, IS THE LOCATION AND AVOIDANCE OF OTHER AIRCRAFT. STATISTICS INDICATE THAT THE PRIMARY HAZARD TO THE AIR CARRIERS IS THE GENERAL AVIATION AIRCRAFT. THE APPROACH UNDER INVESTIGATION IS THE USE OF A CW, DOPPLER SYSTEM OPERATING IN THE MICROWAVE REGION FOR THE MEASUREMENT OF RANGE AND RANGE RATE BETWEEN AIRCRAFT TO EVALUATE THE HAZARD THAT EXISTS. THIS ALLOWS FOR THE DIRECT MEASUREMENT OF THE QUANTITIES OF INTEREST IN THE SIMPLEST FORM ONBOARD THE AIRCRAFT INVOLVED, AND THE DISPLAY OF DERIVED HAZARD INFORMATION TO THE PILOT.

RTOP NO. 125-21-06 TITLE: MICROWAVE TECHNIQUES AND ADVANCED  
COMPONENTS

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: ROBERTS, L. W. TEL. 617-494-2028

TECHNICAL SUMMARY

THE MAJOR OBJECTIVES OF THE WORK IN THIS AREA ARE TO INCREASE THE KNOWLEDGE OF ELECTROMAGNETIC PROPAGATION IN VARIOUS SOLAR AND PLANETARY MEDIA, TO DEVELOP PROTOTYPE SOLID STATE AND OTHER ELECTRONIC COMPONENTS FOR RELATED COMMUNICATION AND EXPERIMENTAL APPLICATIONS, AND TO ADVANCE MILLIMETER WAVE SYSTEM TECHNOLOGY. THE SCOPE OF THE WORK INCLUDES RESEARCH AND DEVELOPMENT ON AEROSPACE ANTENNAS FOR COMMUNICATION LINKS; THE DEVELOPMENT OF MICROWAVE ELECTRONIC AND ACOUSTIC DEVICES FOR POWER GENERATION AND SIGNAL PROCESSING SUB-SYSTEMS; THE MEASUREMENT OF THE TRANSMISSION PROPERTIES OF ATMOSPHERIC GASES AND PLANETARY ATMOSPHERES AT MILLIMETER WAVE FREQUENCIES; AND THE DEVELOPMENT AND USE OF MICROWAVE TECHNOLOGY IN THE STUDY OF THE EARTH AND ITS ATMOSPHERE. THE CONCENTRATION OF RESOURCES AT ERC WILL PROVIDE A UNIQUE ABILITY TO UNDERTAKE LONG RANGE RESEARCH AND DEVELOPMENT AND TO RESPOND TO SHORTER RANGE PROBLEMS. THE WORK RELATES DIRECTLY TO PLANNED PLANETARY EXPLORERS, METEOROLOGICAL SATELLITES, COMMUNICATIONS SATELLITES AND IONOSPHERE SOUNDERS. THE APPROACH INVOLVES THE USE OF SATELLITE DATA, FIELD EXPERIMENTS, AND LABORATORY RESEARCH. BASIC PHENOMENA WILL BE STUDIED AT ERC WITH CONSEQUENT DEVICES AND SUB-SYSTEMS BEING FABRICATED UNDER CONTRACT.

RTOP NO. 125-21-08 TITLE: MICROWAVE NEAR-EARTH COMMUNICATION AND TRACKING

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: JOHNSON, C. C. TEL. 301-982-4936

TECHNICAL SUMMARY

THE ULTIMATE OBJECTIVE OF THIS WORK AREA IS TO PROVIDE THE TECHNOLOGY FOR RELIABLE NEAR EARTH COMMUNICATION AND TRACKING SYSTEMS WHICH THE FUTURE HIGH DATA RATE SPACE PROGRAMS WILL REQUIRE. FOR THIS DEFINITION, HIGH DATA RATES ARE THOSE IN EXCESS OF 10 MEGA BITS PER SECOND. THE UPPER LIMIT ENVISIONED FOR THIS TIME PERIOD BEING 100 MEGA BITS PER SECOND. THESE HIGH DATA RATES WILL BE AN INTEGRAL PART OF SUCH PROGRAMS AS ERTS, MSN SPACE STATION, AND TDRSS. ANALYSIS AND HARDWARE DEVELOPMENT ON MICROWAVE NEAR EARTH COMMUNICATIONS AND TRACKING SYSTEMS WILL BE PERFORMED. THIS COMPREHENSIVE WORK AREA ENCOMPASSES A WIDE FIELD FROM SPACECRAFT ELECTRONICS, AND ANTENNAS TO GROUND ANTENNAS AND ELECTRONICS. THE OTHER ASPECT OF THE PROBLEM IS THE DETAILED ANALYSIS OF THE TRACKING ACCURACY INCLUDING RESEARCH AND DEVELOPMENT OF THE PRIMARY FREQUENCY STANDARD. THE THEORETICAL CONSIDERATIONS OF RELATIVISTIC EFFECTS UPON TRACKING BETWEEN NON-COPLANAR SOLAR ORBITING OBJECTS, AND THE LENSE-THIRING EFFECT WHICH COUPLES IN THE CENTRAL BODY ROTATION, ARE BEING PURSUED TO DETERMINE THEIR EFFECT UPON ORBIT AND TROJECTORY COMPUTATIONS AND TO PERMIT A DEFINITION OF EXPERIMENTS SUITABLE FOR DETECTING GENERAL RELATIVISTIC EFFECTS WHICH ARE UTILIZING NASA TRACKING SYSTEMS.

RTOP NO. 125-21-09 TITLE: MICROWAVE DEEP SPACE COMMUNICATIONS AND TRACKING

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE PURPOSE OF THIS ACTIVITY IS TO INCREASE THE TELEMETRY, COMMAND, AND TRACKING CAPABILITY OF MICROWAVE TELECOMMUNICATIONS LINKS BETWEEN PLANETARY SPACECRAFT AND EARTH DURING THE 1975-1985 PERIOD, BOTH FOR OUTER PLANET MISSIONS AND FOR THOSE NEAR THE SUN. MULTIPLE-MISSION SUB-SYSTEMS ARE STRESSED SO AS TO REDUCE COSTS AND PROVIDE IMPROVEMENT FOR MORE SPACECRAFT PROJECTS. THE EFFORTS TO INCREASE SUCH CAPABILITY FALL NATURALLY INTO TWO AREAS. THE FIRST AREA IMPROVES THE COMMUNICATION CHANNEL BY PROVIDING A GREATER EFFECTIVE POWER-GAIN PRODUCT. THE SECOND AREA IMPROVES THE CHANNEL SO PROVIDED BY UTILIZING IT MORE EFFICIENTLY. IN IMPROVING THE COMMUNICATION CHANNEL, EFFORT IS DIRECTED TOWARD A LOWER NOISE SPACECRAFT RECEIVER, FOR IMPROVING COMMAND AND RANGING; A TRANSMITTER WITH MULTIPLE CATHODES FOR LONG LIFE ON OUTER PLANET MISSIONS; AND A DUAL-FREQUENCY DOWN LINK AT S- AND X-BAND FOR DATA-DUMP TELEMETRY AND DUAL-FREQUENCY TRACKING. A MAJOR EFFORT TO IMPROVE THE CHANNEL IS IN THE AREA OF LARGE UNFURLABLE SPACECRAFT ANTENNAS. STUDIES ON THE CAPABILITIES OF MICROWAVE AS OPPOSED TO STILL HIGHER FREQUENCIES WILL BE CONDUCTED TO DETERMINE THE OPTIMUM FREQUENCIES FOR FUTURE USE, BEARING IN MIND BOTH LIMITED BANDWIDTHS AND WEATHER DEPENDENCE. IN THE AREA OF EFFICIENT CHANNEL UTILIZATION, STUDIES OF THE PLANETARY-INTERPLANETARY MEDIUM WILL BE CONDUCTED IN ORDER TO PROVIDE

BETTER MODULATION AND CODING TECHNIQUES FOR SUCH A CHANNEL. STRUCTURES SUCH AS CONVOLUTIONAL CODES WILL BE INVESTIGATED WHICH COME CLOSER TO THE "SHANNON LIMIT". BANDWIDTH-CONSTRAINED CODING WILL BE INVESTIGATED SO AS TO PROVIDE MORE USEFUL DATA PER ALLOWED CHANNEL CYCLE. NON-PARAMETER DETECTION THEORY WILL BE IMPROVED SO AS TO PROVIDE SIMPLE AND EFFICIENT DATA DETECTORS ON BOARD SPACECRAFT IN LANDER/ORBITER TELEMETRY RELAY LINKS, WHERE THE CHANNEL PARAMETERS ARE UNKNOWN OR RAPIDLY VARYING. INCOHERENT AND PHASE-LOCK DETECTORS WILL BE STUDIED FOR USE IN SPACECRAFT COMMAND RECEIVERS, WITH THE ULTIMATE GOAL OF AVOIDING ROUND TRIP VERIFICATION AT OUTER PLANET DISTANCES.

RTOP NO. 125-21-10 TITLE: ADVANCED CODING TECHNIQUES FOR  
INFORMATION PROCESSING

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: FOSTER, J. V. TEL. 415-961-1111

TECHNICAL SUMMARY

BY 1967, ADVANCED DATA HANDLING SYSTEM DESIGN HAD PROGRESSED TO WITHIN 10 DB OF THE PERFORMANCE LIMIT FOR ERROR-FREE COMMUNICATION THAT WAS DERIVED BY C. E. SHANNON IN HIS MATHEMATICAL THEORY OF COMMUNICATION IN 1948. RESEARCH INTO CODING TECHNIQUES AT AMES, NOW VERIFIED BY FLIGHT EXPERIMENT, HAS REDUCED THE ABOVE 10DB DIFFERENTIAL TO 7 DB. TO FURTHER REDUCE THE PERFORMANCE DIFFERENTIAL, THE FOLLOWING ADDITIONAL CODING RESEARCH TASKS AND SUBSIDIARY STUDIES ARE BEING PURSUED: A. HYBRID CODING TECHNIQUES B. COMBINED DATA COMPRESSION WITH SEQUENTIAL DECODING C. CHANNEL CHARACTERIZATION BY ANALYSIS OF PIONEER IX AND X CODED DATA D. PHASE INSTABILITY COMPENSATION E. PROBABILITY DENSITY FUNCTION GENERATION F. CODING TECHNIQUES/SIGNAL DESIGN FOR VERY LOW DATA RATES PRELIMINARY WORK IS UNDERWAY ON ALL TASKS WITH EXCEPTION OF ITEMS B AND F. TASKS C, D, AND E ARE THE CLOSELY-RELATED SUBSIDIARY STUDIES ESSENTIAL TO PROGRESS IN BASIC CODING RESEARCH.

RTOP NO. 125-21-14 TITLE: MICROWAVE ELECTRON TUBES FOR SPACE  
SHUTTLE VEHICLE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE MAJOR OBJECTIVES OF THE WORK IS THE DEVELOPMENT AND MODIFICATION OF A-BAND MICROWAVE ELECTRON TUBE FOR THE COMMUNICATION SUBSYSTEM OF THE SPACE SHUTTLE VEHICLE. THIS TUBE WILL BE COMPATIBLE WITH THE VEHICLE COMMUNICATION TRANSMITTER USED IN CONJUNCTION WITH THE INTELSATV SYSTEM. THE ONLY ELECTRON TUBE DEVELOPMENT TO BE UNDERTAKEN WILL BE IN CONNECTION WITH THE C-BAND DEVICE WITH A NOMINAL SATURATED POWER OUTPUT OF 100 WATTS. THIS TUBE WILL BE USEFUL FOR POWER OUTPUTS IN THE 20 TO 100 WATT RANGE. OVERALL EFFICIENCY AND RELIABILITY ARE OF THE UTMOST IMPORTANCE. INTERMODULATION REQUIREMENTS WILL BE CAREFULLY CONSIDERED AND ALTERNATE APPROACHES TO ACHIEVING ADEQUATE COMMUNICATION CHARACTERISTICS WITH HIGH EFFICIENCY MAY BE UNDERTAKEN IF DESIRABLE.

THE FINAL ENGINEERING MODELS WILL BE SUITABLE FOR SPACE OPERATION AND FINAL SPECIFICATIONS WILL BE PREPARED BY APRIL 1971 WHICH CAN BE UTILIZED FOR SYSTEMS ENGINEERING TO ASSURE COMPATIBILITY OF THE TRANSMITTER WITH THE ANTENNA AND OTHER CRITICAL SUBSYSTEM ELEMENTS.

RTOP NO. 125-21-15 TITLE: CODING FOR SPACE STATION COMMUNICATIONS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: FOSTER, J. V. TEL. 415-961-1111

TECHNICAL SUMMARY

FLIGHT EXPERIENCE ON THE PIONEER PROGRAM HAS DEMONSTRATED THAT ERROR-CORRECTION CODING OF THE TELEMETRY DATA CAN PROVIDE A SUBSTANTIAL SYSTEM GAIN. THIS SYSTEM HAS BEEN USED AT THE LOW DATA RATES ASSOCIATED WITH DEEP SPACE PROBES. EXTENSION OF THESE TECHNIQUES FOR MILITARY APPLICATION HAS DEMONSTRATED SIMILAR GAINS AT DATA RATES OF 5 MOPS. IT IS PROPOSED TO DEVELOP CODING TECHNIQUES FOR SPECIFIC APPLICATION TO COMMUNICATION LINKS FOR A SPACE STATION/BASE PROGRAM WITH DATARATE REQUIREMENTS GREATER THAN 15 MBPS.

DATA CODING WILL INSURE THE EXTREMELY LOW ERROR RATES REQUIRED BY THE INCLUSION OF DATA COMPRESSION TECHNIQUES IN THE LINKS, IN ADDITION TO PROVIDING A SYSTEM GAIN. A STUDY TO DEVELOP, EVALUATE, AND SELECT THE MOST APPROPRIATE CODING TECHNIQUE FOR THIS APPLICATION WILL BE THE FIRST PHASE OF THIS EFFORT. THIS PHASE WILL BE FOLLOWED BY A PAPER DESIGN, CONSTRUCTION OF A LABORATORY PROTOTYPE AND ASSOCIATED CHECKOUT EQUIPMENT, AND A FINAL SYSTEM PERFORMANCE EVALUATION.

RTOP NO. 125-21-17 TITLE: SPACE SHUTTLE LOW NOISE RECEIVER  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: JOHNSON, C. C. TEL. 301-982-4936

TECHNICAL SUMMARY

THE SPACE SHUTTLE COMMUNICATION THROUGH GEOCENTRIC SATELLITES WILL REQUIRE INCREASED ANTENNA SIZES OR MORE SENSITIVE RECEIVING SYSTEMS. SINCE RE-ENTRY IS A FACTOR, IT IS OBVIOUS THAT THE LATTER AREA OF CONCERN SHOULD BE DEVELOPED. THIS RTOP WILL DEVELOP A SPACE QUALIFIED PARAMP TECHNOLOGY (INCLUDING FLIGHT HARDWARE) AT C-BAND AND X-BAND. THE C-BAND PARAMP WILL HAVE A NOISE FIGURE OF LESS THAN 2DB AND THEREBY SIGNIFICANTLY REDUCE THE SIZE REQUIREMENT OF THE ANTENNA.

THIS EFFORT WILL BE PRIMARILY CONTRACTUAL WITH SOME PARALLEL EFFORT PERFORMED IN-HOUSE. THE C-BAND UNIT MUST BE DEVELOPED COMPLETELY, WHEREAS THE PROTOTYPE X-BAND UNIT WILL BE DEVELOPED FOR THE FDRS PROGRAM. THIS PROTOTYPE MUST THEN BE DEVELOPED THROUGH THE SPACE QUALIFICATION SEGMENT.

RTOP NO. 125-22-04 TITLE: TELESCOPE TECHNOLOGY AND ASTRONOMICAL  
TECHNIQUES

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: INGRAO, H. C. TEL. 617-494-2373

TECHNICAL SUMMARY

TO CARRY OUT ASTRONOMICAL OBSERVATIONS USING LARGE (IN THE ORDER OF 120-IN. APERTURE) SPACE BORNE OPTICAL TELESCOPES AND LIMITED ONLY BY DIFFRACTION OR THE STATISTICAL NOISE OF THE RADIATION RECEIVERS IN THE ACCESSORY EQUIPMENT, IT IS REQUIRED TO DEVELOP A NEW TELESCOPE TECHNOLOGY ALONG WITH ASTRONOMICAL OBSERVATIONAL TECHNIQUES. IN REGARD TO THE TELESCOPE, THE PROBLEMS ARE IN THE DESIGN, CONSTRUCTION, LAUNCHING, AND IN ACHIEVING AND MAINTAINING PERFORMANCE OF A LARGE TELESCOPE IN AN EARTH'S ORBIT AND LIMITED ONLY BY DIFFRACTION. DISTORTIONS OF THE TELESCOPE MIRROR SURFACES WHEN IN ORBIT AND DUE TO THERMAL GRADIENTS AND ELASTIC DEFORMATIONS, LACK OF COLLIMATION OF THE MIRRORS, MIRROR SURFACE IMPERFECTIONS AND DEGRADATION WILL BE AMONG THE LIMITING FACTORS OF THE TELESCOPE PERFORMANCE. ALSO, THE MANUFACTURING OF LARGE MIRRORS FOR THE PLANNED TELESCOPES MUST ACHIEVE SURFACE PRECISIONS FAR NOT OBTAINED. LACK OF WELL-DEFINED QUALITY CONTROL AND CHARACTERIZATION OF THE CANDID MIRROR MATERIALS, OPTIMUM DESIGN OF THE MIRROR STRUCTURE, MIRROR EVALUATION, ETC. ARE ALSO PART OF THE LIMITATIONS IN ACHIEVING THE DESIRED DIFFRACTION LIMITED PERFORMANCE OF LARGE SPACE TELESCOPES. IT IS MORE EFFECTIVE TO CONDUCT RESEARCH ON TELESCOPES SIMULTANEOUSLY WITH RESEARCH ON ASTRONOMICAL TECHNIQUES. THIS IS DUE TO THE CLOSE RELATIONSHIP BETWEEN THE TWO AREAS WHICH SOMETIMES ARE DIFFICULT TO SEPARATE. OBSERVATIONS THROUGHOUT THE ENTIRE ELECTROMAGNETIC SPECTRUM ARE POSSIBLE FROM SPACE. SINCE TECHNIQUES DIFFER FOR VARIOUS RANGES OF ELECTROMAGNETIC SPECTRUM, WE WILL CONCENTRATE ON ONE RANGE--THE SUBMILLIMETER. SINCE THE EARTH'S ATMOSPHERE IS OPAQUE NO SUBMILLIMETER RADIATION, NO RELIABLE TECHNIQUES OR MEASUREMENTS ARE AVAILABLE. THE EFFORT OF HRC IN THESE AREAS WILL PROVIDE A UNIQUE ABILITY TO UNDERTAKE LONG-RANGE RESEARCH AND TO RESPOND TO SHORTER RANGE QUESTIONS. ALSO, THIS EFFORT GIVES GOOD OPPORTUNITY FOR INTER-HRC COOPERATION AND WITH OTHER NASA CENTERS INVOLVED IN THE DEVELOPMENT OF LARGE OPTICAL TELESCOPES.

RTOP NO. 125-22-05 TITLE: OPTICAL COMMUNICATIONS AND TRACKING

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: HULL, J. A. TEL. 617-494-2595

TECHNICAL SUMMARY

OBJECTIVES: PURSUE A BROAD ANALYTICAL AND EXPERIMENTAL PROGRAM FOR THE GENERATION, MODULATION, DETECTION AND AMPLIFICATION OF VISIBLE AND INFRARED RADIATION. OPTICAL COMMUNICATIONS OFFERS THE POTENTIAL FOR EXTREMELY WIDE BANDWIDTH AND HIGH EFFICIENCY SYSTEMS. THE WIDE BANDWIDTH RESULTS FROM THE HIGH CARRIER FREQUENCY AT OPTICAL WAVELENGTHS AND THE HIGH EFFICIENCY IS ACHIEVED THROUGH GOOD CONVERSION EFFICIENCY OF ELECTRICAL TO RADIATED POWER AND THROUGH THE EXTREMELY HIGH ANTENNA GAIN ACHIEVABLE AT SHORT WAVELENGTHS. APPLICATIONS: COMMUNICATION LINKS: SATELLITE-TO-SATELLITE, SATELLITE-TO-EARTH, DEEP-SPACE, DEEP-SPACE TO EARTH, COMPUTER-TO-COMPUTER (TERRESTRIAL); OPTICAL AIDS TO AVIONICS



ASTRONOMY AND METEOROLOGY. APPROACH: DEVELOPMENT OF LASER SOURCES: MODULATION AND DETECTION TECHNIQUES, SYSTEM STUDIES AND SPACE QUALIFICATION OF SUBSYSTEM COMPONENTS WHICH APPLIES TO OPTICAL COMMUNICATIONS. SYSTEMS ARE AIMED TOWARD HIGH-DATA-RATE TRANSMISSION, UTILIZING LARGE COLLECTIVE OPTICS.

RTOP NO. 125-22-06 TITLE: OPTICAL TECHNOLOGY TEST AND OPERATION  
STATION

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: ROBERTS, L. W. TEL. 617-494-2028

TECHNICAL SUMMARY

AN OPTICAL FIELD STATION IS REQUIRED TO MEET NASA'S OPTICAL TECHNOLOGY REQUIREMENTS IN THE AREAS OF OPTICAL COMMUNICATION VISIBLE AND INFRA-RED ASTRONOMY, AND IN THE CHECKING OUT OF NEWLY DEVELOPED OPTICAL SENSORS AND DETECTORS. SUCH AN OPTICAL TEST AND OPERATION FACILITY CAN PROVIDE OPTICAL FIELD TESTS AND MEASUREMENTS IN SUPPORT OF SUCH FLIGHT MISSIONS AS: ATS-F AND G, ERTS-1 AND 2, AAP1/2 AND 3/4, AND EOSS. THE INITIAL APPROACH IS TO DETERMINE THE OPTIMUM SITE SELECTION BASED ON BOTH TECHNICAL AND LOGISTIC CONSIDERATIONS. MEASUREMENTS OF ATMOSPHERIC TRANSPARENCY AND EMISSION AT VARIOUS WAVELENGTHS TO DETERMINE LOCAL ATMOSPHERIC STABILITY AND SUITABILITY WILL BE MADE AT THE SITE AND FROM RADIOSONDE FLIGHTS.

RTOP NO. 125-22-07 TITLE: PILOT WARNING INDICATOR RESEARCH PROGRAM

ORGANIZATION: ELECTRONICS RES. CTR.

MONITOR: RHINE, W. J. TEL. 617-494-2024

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO CARRY OUT RESEARCH ON PILOT WARNING INDICATOR SYSTEMS (PWI). THIS IS A CLASS OF ANTI-COLLISION SYSTEMS DESIGNED TO SUPPLEMENT VFR FLIGHT AND IS AIMED AT A LOW-COST LIGHT WEIGHT SYSTEM FOR GENERAL AVIATION. ANALYTICAL STUDIES HAVE LED TO THE DESIGN AND CONSTRUCTION OF PROOF-OF- CONCEPT MODELS. OPTIMUM SYSTEM AND SUBSYSTEM CONFIGURATIONS AND PERFORMANCE CHARACTERISTICS WILL BE INVESTIGATED THROUGH FURTHER ANALYSIS AND EXTENSIVE FLIGHT TESTING. OPERATIONAL PERFORMANCE WILL BE OBTAINED FROM THE FLIGHT TEST PROGRAM. THE FIRST PHASE OF THE PROGRAM INVOLVES USE OF A PASSIVE SILICON DETECTOR SYSTEM TO DETECT A XENON FLASHING LIGHT SUCH AS IS CARRIED BY MANY AIRCRAFT. THE PILOT IS NOTIFIED OF THE PRESENCE OF THE OTHER AIRCRAFT BY VISUAL OR VISUAL-AUDIBLE DISPLAY. RELATIVE BEARING INFORMATION IS PRESENTED TO THE PILOT AND HE MUST VISUALLY ACQUIRE THE OTHER AIRCRAFT AND ASSESS THE POTENTIAL HAZARD. A SECOND PHASE, ALREADY UNDERWAY, IS TO ADD DISCRIMINATION OR THREAT ASSESSMENT CAPABILITY TO THE SYSTEM BY TRANSMITTING AIRCRAFT FLIGHT INFORMATION SUCH AS AIRSPEED, RELATIVE HEADING, ALTITUDE, ETC. THIS INFORMATION IS ENCODED ON THE FLASHING LIGHT. ELECTRONIC SUBSYSTEMS FOR THE ENCODING AND DECODING ARE BEING PROCURED AND SYSTEM ANALYSES WILL BE PERFORMED TO DETERMINE THE OPTIMUM DATA SET TO BE USED.



RTOP NO. 125-22-08 TITLE: OPTICAL COMMUNICATIONS AND TRACKING  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: PLOTKIN, H. H. TEL. 301-982-5503  
TECHNICAL SUMMARY

PROGRAM CONDUCTS STUDIES AND DEVELOPS TECHNOLOGY OF COMPONENTS, SYSTEMS, AND OPERATIONAL TECHNIQUES FOR SPACECRAFT COMMUNICATION AND TRACKING WITH LASERS. OPTICAL TECHNOLOGY IS DIRECTED TOWARD SATISFYING NASA'S NEED FOR PRECISION TRACKING AND HIGH DATA RATE COMMUNICATION IN THE 1970 TO 1985 ERA. USING LATEST DEVELOPMENTS FROM CONTINUOUSLY CHANGING STATE-OF-THE-ART PROOF-OF-CONCEPT MODELS OF LASER TRANSMITTERS, RECEIVERS, MODULATORS, AND TELESCOPES, ARE DESIGNED AND CONSTRUCTED. PERFORMANCE OF COMPONENTS AND SYSTEMS IS MEASURED IN LABORATORY AND FIELD STATIONS UNDER CONDITIONS IN WHICH EFFECTS OF ENVIRONMENTAL PERTURBATIONS SUCH AS ATMOSPHERIC PROPAGATION, ACOUSTIC VIBRATION, AND SOLAR RADIATION BACKGROUND CAN BE STUDIED, LEADING TO THEORETICAL SYSTEMS ANALYSIS AND SELECTION OF OPTIMUM COMPONENTS AND PARAMETERS. PROTOTYPE TRACKING AND COMMUNICATION TERMINALS ARE DEVELOPED AND EMPLOYED IN EXPERIMENTS WITH SATELLITE EQUIPMENT SUCH AS PASSIVE REFLECTORS, LASER DETECTORS, AND RADIATING SOURCES, IN ORDER TO PROVE CONCEPTS AND PROVIDE BASELINE DATA FOR SPECIFIC APPLICATION DESIGNS, GSFC EMPHASIS IS ON DEVELOPMENT AND EVALUATION OF COMPLETE OPERATIONAL SYSTEMS NEEDED FOR SPACE LASER APPLICATIONS. FUNDAMENTAL RESEARCH IN MATERIALS AND DEVICES, COMPONENT OPERATIONS, CONTROL SYSTEMS, AND ENVIRONMENTAL PROPERTIES ARE PERFORMED WHEN NECESSARY FOR DIRECT SUPPORT OF SYSTEM DEVELOPMENT, TEST, AND ANALYSIS.

RTOP NO. 125-22-09 TITLE: LARGE TELESCOPE TECHNOLOGY  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: PLOTKIN, H. H. TEL. 205-453-1120  
TECHNICAL SUMMARY

THIS RESEARCH PROGRAM IS DESIGNED TO PROVE THE CONCEPT OF ESTABLISHING AND OPERATING LARGE DIFFRACTION LIMITED OPTICS IN SPACE. SPECIFICALLY, THIS WORK WILL LEAD TO A FULLY OPERATIONAL ORBITING NATIONAL ASTRONOMICAL SPACE OBSERVATORY (NASO) IN THE 1981-1982 TIME PERIOD. IN PREPARATION FOR THIS, MSFC AND OTHER NASA ELEMENTS, IN COOPERATION WITH MEMBERS OF THE ASTRONOMICAL COMMUNITY, HAVE DEFINED A SET OF PROOF OF CONCEPT ACTIVITIES WHICH SHOULD GUARANTEE THE AVAILABILITY OF NECESSARY TECHNOLOGY TO MAKE THE NASO A PRACTICAL VENTURE. THE PROOF OF CONCEPT ACTIVITIES HAVE BEEN CATEGORIZED AS TO METHOD OF EXPERIMENTAL SOLUTION SUCH AS EARTH LABORATORY, AIRCRAFT OR BALLOON, AND TRUE SPACE FLOWN EXPERIMENTS. AS MANY INDIVIDUAL CONCEPT ELEMENTS AS IS ECONOMICALLY FEASIBLE WILL BE SPACE TESTED AS EARLY IN THE PROGRAM AS POSSIBLE. IT IS PLANNED TO VERIFY THE BULK OF THE CONCEPTS ON AN INTERMEDIATE 2 TO 3 METER DIFFRACTION LIMITED TELESCOPE SYSTEM IN THE 1975-1978 PERIOD. THIS INTERMEDIATE SCIENCE/TECHNOLOGY TELESCOPE FITS WITHIN THE DRY WORKSHOP, SPACE STATION/BASE, AND SHUTTLE CONCEPTS AND WOULD BECOME AN OPERATING PART OF SUCH STATION COMPLEXES. IT WILL CARRY ABOUT 7 ASTRONOMY SCIENCE PACKAGES DETERMINED BY OSSA. AFTER A 3 TO 4 MONTH TECHNOLOGY VERIFICATION PERIOD, THE SYSTEM WILL BE TURNED OVER TO ASTRONOMERS FOR SCIENTIFIC PURPOSES. IT WILL BE RECLAIMED FOR PERIODIC

TECHNOLOGY CHECKS AS THE NEED ARISES. SUCH CHECKS WILL SERVE AS PHASE A CONCEPT VERIFICATION FOR THE FULLY OPERATIONAL NASO, WHICH WILL ULTIMATELY BE A 3 TO 10 METER DIFFRACTION LIMITED INSTRUMENT.

RTOP NO. 125-22-10 TITLE: OPTICAL COMMUNICATION TECHNOLOGY

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: PLOTKIN, H. H. TEL. 205-453-1120

TECHNICAL SUMMARY

THIS RESEARCH PROGRAM IS DESIGNED TO PROVE THE CONCEPT OF COMMUNICATING BETWEEN EARTH AND SPACE BY UTILIZING THE UNIQUE POTENTIAL OF THE OPTICAL PORTION OF THE ELECTROMAGNETIC SPECTRUM. THE NECESSARY TECHNOLOGY BASE WILL BE ESTABLISHED TO PERMIT OPERATIONAL OPTICAL COMMUNICATION SYSTEMS TO BE EMPLOYED IN THE 1975 TO 1980 TIME PERIOD. THE EARTH/SPACE OPTICAL COMMUNICATION CONCEPT APPEARS MOST ATTRACTIVE AND TECHNICALLY FEASIBLE. HOWEVER, PRACTICAL ASPECTS AND LIMITS MUST BE INVESTIGATED AND DEFINED PRIOR TO MAKING OPERATIONAL COMMITMENTS FOR THE SYSTEM. THE NEAR-EARTH PORTION OF THE MSFC PROGRAM WILL CONSIST OF FOUR AIRCRAFT FLIGHT PACKAGES FOR A U-2 OR RB-57 TYPE AIRCRAFT. EACH PACKAGE WILL BE FLOWN OVER THE MSFC GROUND STATION FOR SEVERAL HOURS AT 50,000, 60,000 AND 70,000 FOOT ALTITUDE UNDER VARYING ATMOSPHERIC CONDITIONS TO DETERMINE THE EFFECTS OF THE ATMOSPHERE ON THE UP AND DOWN LASER BEAMS. THE INDIVIDUAL PACKAGE TEST PERIODS WILL BEGIN SEPTEMBER 1970 AND BE SPACED AT SIX MONTH INTERVALS. THE INFORMATION GAINED FROM THE AIRCRAFT TESTS WILL FEED DIRECTLY INTO THE SPACE FLIGHT PACKAGE DESIGN. CURRENTLY IT APPEARS THAT THE SPACE FLIGHT PORTION OF THE PROGRAM CAN BE DONE WITH TWO SCOUT VEHICLES OR ONE THOR (OR LARGER) VEHICLE OR AS A MODULE ON AN ESTABLISHED LAUNCH (SUCH AS ATS-G). PRELIMINARY DEVELOPMENT DESIGN AND SIZING IS UNDERWAY FOR THE VARIOUS POTENTIAL FLIGHT PACKAGES.

RTOP NO. 125-22-11 TITLE: PHOTOHELIOGRAPH DEVELOPMENT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

WORK CARRIED OUT ON THE ATM PHOTOHELIOGRAPH BEFORE THE PROGRAM WAS TERMINATED DISCLOSED THAT MANY SERIOUS PROBLEMS EXIST WHICH HAVE TO BE SOLVED BEFORE GROUND TESTING OF A NEAR DIFFRACTION-LIMITED TELESCOPE CAN BE ACCOMPLISHED. THE OBJECTIVE OF THIS TASK IS TO REVIEW AND EVALUATE TECHNIQUES APPLICABLE TO MICROSTRAIN PROPERTY MEASUREMENTS OF POTENTIAL MIRROR MATERIALS AND TO DEVELOP REQUIRED MODIFICATIONS TO OBTAIN RELIABLE DATA AT STRAIN VALUES OF  $10^{-8}$ . THE APPROACH WILL BE TO BECOME INFORMED OF PRESENT ACTIVITIES IN MICROSTRAIN PROPERTY MEASUREMENTS, TO RECOMMEND WHAT MODIFICATIONS IN TECHNIQUES, IF ANY, MAY BE NECESSARY, AND TO MEASURE MICROSTRAIN PROPERTIES OF CANDIDATE MATERIALS.

RTOP NO. 125-22-12 TITLE: OPTICAL TECHNIQUES AND ADVANCED COMPONENTS  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: ROBERTS, L. W. TEL. 617-494-2028  
TECHNICAL SUMMARY

OPTICAL AND INFRARED TECHNIQUES AND COMPONENTS WILL BE DEVELOPED FOR USE IN THE NASA MISSIONS. APPLICATIONS OF THE RESULTS WILL BE FOUND IN HIGH SPEED DATA TRANSMISSION FROM SPACE TO EARTH AND FROM SPACE TO SPACE, IN OPTICAL AIDS TO AERONAUTICS, IN ASTRONOMICAL AND NON-ASTRONOMICAL IMAGING, IN PHOTOGRAPHY, RADIOMETRY AND OTHER TYPES OF OPTICAL REMOTE SENSING, AND IN DATA STORAGE AND COMPRESSION. THE PROGRAM WILL INCLUDE THEORETICAL AND EXPERIMENTAL RESEARCH IN DIVERSE TOPICS IN OPTICS SUCH AS THE PROPAGATION OF ELECTROMAGNETIC WAVES IN THE ATMOSPHERE, RELAXATION PHENOMENA IN MOLECULAR GASES, LASER OPERATIONAL TECHNIQUES, NON-LINEAR OPTICAL PHENOMENA, HOLOGRAPHIC AND OTHER ANALOG METHODS OF DATA PROCESSING AND STORAGE, FAR INFRARED INSTRUMENTATION DEVELOPMENT, RETRIEVAL OF INFORMATION FROM IMAGES DEGRADED BY TURBULENCE, IMAGE MOTION, AND INSTRUMENTAL DEFICIENCIES, AND LASER MODULATION TECHNIQUES. THERE WILL BE IN-HOUSE WORK AS WELL AS UNIVERSITY GRANTS AND CONTRACTS. THE RESULTS OF THE PROGRAM WILL APPEAR PRIMARILY IN THE FORM OF NASA REPORTS, SCIENTIFIC PAPERS, RECOMMENDATIONS TO OTHER NASA CENTERS, BOOKS, CHAPTERS IN BOOKS, CONTENTS, AND PROTOTYPE HARDWARE.

RTOP NO. 125-22-14 TITLE: ADVANCED OPTICAL COMMUNICATION RESEARCH  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: MESON, J. K. TEL. 202-962-7335  
TECHNICAL SUMMARY

THIS PROGRAM OF RESEARCH IS DIRECTED TOWARDS PROVIDING NASA WITH FUNDAMENTAL TOOLS AND METHODS OF OPTICAL COMMUNICATION AT DEEP SPACE AND INTERPLANETARY DISTANCES FOR MISSIONS IN THE 1970 - 1985 TIME PERIOD. THE FUTURE REQUIREMENTS FOR WIDE BAND, HIGH DATA RATE COMMUNICATION CAN BEST BE SATISFIED BY OPTICAL SYSTEMS USING LASER TECHNOLOGY. THE PRESENT PROGRAM WILL ADVANCE THE STATE-OF-ART TECHNOLOGY BY MEANS OF TWO GRANTS FOR RESEARCH IN LASER TRANSMITTERS, MODULATORS, RECEIVERS AND OPTIMAL COMMUNICATION TECHNIQUES, AND WILL COMPLEMENT RELATED RESEARCH AND DEVELOPMENT AT NASA FIELD CENTERS.

RTOP NO. 125-22-15 TITLE: ACTIVE OPTICS SYSTEMS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: REID, H. J. E., JR. TEL. 703-827-3551  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP TECHNIQUES FOR MAINTAINING DIFFRACTION-LIMITED PERFORMANCE IN ASTRONOMICAL SPACE TELESCOPE SYSTEMS. SPACE TELESCOPE SYSTEMS DO NOT SUFFER FROM THE GRAVITY LOADS AND THE ATMOSPHERIC FILTERING AND JITTER THAT LIMIT THE PERFORMANCE OF EARTH-BOUND TELESCOPES. IN ORDER TO MAKE MAXIMUM USE OF THE SPACE ENVIRONMENT, THE OPTICAL SYSTEMS MUST BE MAINTAINED IN PRECISE ALIGNMENT, AND THE MIRROR SHAPES MUST BE MAINTAINED TO WITHIN  $1/50$  WAVELENGTH. THE EFFECTS OF THE LAUNCH ENVIRONMENT, THE STRESSES ASSOCIATED WITH THE CHANGE FROM 1 G TO 0 G ENVIRONMENT, THE EFFECTS

OF HEAT INPUTS, AND THE BASIC MATERIAL STABILITIES MAKE THE USE OF A CONVENTIONAL PASSIVE MIRROR DOUBTFUL. TECHNIQUES WILL BE DEVELOPED WHICH USE CONTROL SYSTEMS TO ACTIVELY CONTROL THE SHAPE OF THE MIRROR SURFACES, AND THE ALINEMENT OF THE OPTICAL ELEMENTS, TO THE ACCURACY REQUIRED FOR DIFFRACTION-LIMITED OPERATION UNDER THE INFLUENCE OF VARYING LOADS AND STRESSES.

RTOP NO. 125-23-04 TITLE: GROUND DIGITAL COMPUTER SYSTEM TECHNOLOGY  
FOR AEROSPACE RESEARCH APPLICATIONS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE GOAL OF THE RESEARCH UNDER THIS RTOP IS THE DEVELOPMENT OF PRACTICAL METHODS FOR MEASURING SYSTEM PERFORMANCE AND EFFICIENCY IN ORDER TO DETERMINE LIMITATIONS OF CONTEMPORARY DIGITAL SYSTEMS AND ESTABLISH INDICES FOR FUTURE GROUND COMPUTER SYSTEMS DESIGNS. AS AN INTEGRAL PART OF THE ASSESSMENT, ADVANCED PROBLEM FORMULATION, PROGRAMING, INPUT-OUTPUT AND DATA HANDLING METHODS WILL BE DEVELOPED AND EVALUATED WITH RESPECT TO THEIR IMPACT ON SYSTEM PERFORMANCE. THE GAINS DERIVED FROM THIS EFFORT WILL RESULT IN MORE EFFECTIVE UTILIZATION OF LARGE SCALE DIGITAL COMPUTERS IN ANALYTICAL STUDIES, DATA REDUCTION AND REAL TIME FLIGHT SIMULATION, THROUGH THE PROVISION OF IMPROVED PROGRAM DEBUGGING AND VALIDATION METHODS, MORE EFFICIENT COMPUTATIONAL TECHNIQUES, AND IMPROVED COMMUNICATION BETWEEN THE RESEARCHER AND HIS PROBLEM AS IT IS SOLVED ON THE COMPUTER. SYSTEM PERFORMANCE MEASUREMENT TECHNIQUES WILL BE DEVELOPED TO IDENTIFY DEFICIENCIES IN EXISTING SYSTEMS TO IMPROVE THEIR OPERATING EFFICIENCY AS WELL AS TO PROVIDE INSIGHTS INTO THE DESIGN OF FUTURE SYSTEMS.

RTOP NO. 125-23-05 TITLE: BATCH-FABRICATED MAGNETIC TECHNIQUES FOR  
ONBOARD DATA SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

RESEARCH WILL BE UNDERTAKEN ON FERRITE MATERIAL COMPOSITION, MATERIALS SYNTHESIS, PROCESSING TECHNIQUES TO DEFINE BATCH FABRICATION METHODS FOR BOTH MONOLITHIC MAGNETIC MEMORIES AND MULTIMATERIAL MAGNETIC COMPUTER LOGIC. ADVANTAGE WILL BE TAKEN OF THE SUPERIOR INHERENT RELIABILITY OF FERRITE MATERIALS TO PROVIDE LOW-COST, BATCH-FABRICATED MEMORIES AND LOGIC CAPABLE OF 5-10 YEAR OPERATION. MAGNETIC CIRCUITS, DEVICES, AND SUBSYSTEM CONFIGURATIONS MOST CAPABLE OF PROVIDING ULTRA-RELIABLE PERFORMANCE IN COMPUTERS, SEQUENCERS, AND PROGRAMMERS WILL BE INVESTIGATED AND STUDIED FOR THEIR APPLICATION TO AIRCRAFT AUTOMATIC APPROACH AND LANDING SYSTEMS, REUSABLE SPACE STATION SHUTTLE CRAFT SYSTEMS, AND FOR INTERPLANETARY MISSIONS.

RTOP NO. 125-23-07 TITLE: ADVANCED AEROSPACE COMPUTER SYSTEMS AND  
COMPONENT TECHNOLOGY

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: VAN METER, D. TEL. 617-494-2646

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE DEVICES AND SYSTEMS TECHNOLOGY FOR ON-BOARD DATA PROCESSING AND COMPUTING SYSTEMS FOR ADVANCED MISSIONS OF THE 1973-80 ERA. HIGH PERFORMANCE DATA PROCESSING CONFIGURATIONS WITH USEFUL LIFETIMES UP TO TEN YEARS FOR LONG DURATION EARTH AND PLANETARY MISSIONS ARE TO BE EMPHASIZED. DIGITAL LOGIC, CIRCUIT AND PACKAGING TECHNIQUES ARE TO BE DEVELOPED MEET THE RELIABILITY AND ENVIRONMENTAL CONSTRAINTS OF THESE ADVANCED MISSIONS. ULTRA-HIGH CAPACITY, SOLID STATE, BULK STORAGE TECHNIQUES ARE TO BE SOUGHT TO MEET THE NEEDS OF HIGH DATA RATE MISSIONS FOR LONG LIFETIME BULK STORAGE OF GREATER RELIABILITY AND CAPACITY THAN THAT ACHIEVABLE WITH MOVING PART DEVICES SUCH AS TAPE RECORDERS. EMPHASIS WILL BE GIVEN TO CONTINUATION OF RESEARCH IN MULTIPROCESSOR CONFIGURATIONS INCLUDING DEVELOPMENT OF AN IN-HOUSE TEST BED FOR EVALUATION OF PROTOTYPE SYSTEM HARDWARE AND SOFTWARE, SYSTEM CHECKOUT TECHNIQUES AND INPUT/OUTPUT METHODS.

RTOP NO. 125-23-08 TITLE: ADVANCED DATA PROCESSING TECHNIQUES FOR  
HIGH DATA RATE MISSIONS

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: VAN METER, D. TEL. 617-494-2646

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE TECHNIQUES FOR HANDLING AND PROCESSING THE EXTREMELY LARGE VOLUMES OF DATA WHICH WILL BE GENERATED BY THE MULTIPLICITY OF SENSORS ANTICIPATED ON FUTURE SPACE STATIONS, EARTH SURVEY AND PLANETARY EXPLORATION SPACECRAFT IN THE 1973-80 TIME PERIOD. ON-BOARD DATA MANAGEMENT FUNCTIONS WILL BE EMPHASIZED FOR MISSIONS WHICH CAN BE EXPECTED TO GENERATE DATA AT RATES UP TO  $5 \times 10^8$  BITS/SEC. DATA COMPRESSION, PATTERN RECOGNITION AND SELF-LEARNING MACHINE TECHNIQUES WILL BE DEVELOPED FOR AUTOMATIC EXTRACTION OF SIGNIFICANT INFORMATION FROM MULTISPECTRAL SENSORS TO PROVIDE MAXIMUM INFORMATION TRANSFER OVER LIMITED BANDWIDTH COMMUNICATIONS CHANNELS. AUTOMATED AND MANUAL INTERACTIVE COMPUTER TECHNIQUES WILL BE DERIVED FOR ON-BOARD CHECKOUT AND FOR MANIPULATION DISPLAY, PROCESSING AND ANALYSIS TO AID IN EXTRACTING INFORMATION FROM EXTREMELY LARGE VOLUMES OF DATA. SIMULATION AND MODELING TECHNIQUES (USING ADVANCED EARTH SURVEY MISSIONS AS A TYPICAL EXAMPLE) WILL BE DEVELOPED AS A TOOL FOR DETERMINING TRADEOFFS, EXERCISING AND EVALUATING CONCEPTUAL DESIGNS OF LARGE SCALE DATA MANAGEMENT AND ANALYSIS SYSTEMS.

RTOP NO. 125-23-09 TITLE: ADVANCED AEROSPACE DATA PROCESSING THEORY  
AND TECHNIQUES

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: VAN METER, D. TEL. 617-494-2646

TECHNICAL SUMMARY

THE OBJECTIVES ARE TO INCREASE THE AVAILABILITY OF COMPUTER POWER TO THE USER THROUGH THE EVOLUTION OF NEW PROGRAMMING AND INPUT/OUTPUT TECHNIQUES, AND ADVANCES IN BASIC UNDERSTANDING OF MACHINE CAPABILITY. BASIC STRUCTURE OF COMPUTER SYSTEMS IN RELATION TO HUMAN OPERATORS WILL BE STUDIED TO DEVELOP A MORE FLEXIBLE AND NATURAL MEANS OF MAN/MACHINE COMMUNICATION. THE PROBLEMS UNDERLYING CURRENT DIFFICULTIES WITH SOFTWARE DEVELOPMENT ARE TO BE IDENTIFIED; NEW FUNDAMENTAL APPROACHES ARE TO BE EXPLORED, RATHER THAN AD HOC TREATMENT OF SYMPTOMS (SOFIX). EMPHASIS WILL BE GIVEN TO MORE NATURAL PROGRAMMING AND COMMAND LANGUAGES WHICH CAN BE EASILY AND ECONOMICALLY IMPLEMENTED. ON-LINE INTERACTIVE AND TIME-SHARING TECHNIQUES ARE TO BE EXPLORED FOR APPLICATION TO REAL TIME VEHICLE AND MISSION CONTROL PROBLEMS. ADVANCED TECHNIQUES ARE TO BE SOUGHT FOR ALLOCATING THE RESOURCES OF MULTIFUNCTIONAL COMPUTERS IN MULTIPLE-USER, INTERACTIVE ENVIRONMENTS. HEURISTIC METHODS AND PROGRAMMED ARTIFICIAL INTELLIGENCE WILL BE EMPHASIZED IN THE SEARCH FOR AUTONOMOUS MACHINES CAPABLE OF SELF-TEACHING AND DECISION-MAKING OF THE TYPES NEEDED FOR ULTIMATE APPLICATION TO AUTOMATED REMOTE PLANETARY SURFACE EXPLORATION. RELATED WORK IN SOFTWARE EVALUATION, BASED ON ANALYSIS OF OPERATIONAL EXPERIENCE, IS BEING CONDUCTED AT LARC.

RTOP NO. 125-23-10 TITLE: ADVANCED DATA PROCESSING TECHNOLOGY FOR  
SCIENTIFIC/APPLICATIONS SATELLITES

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: VAN ALLEN, R. L. TEL. 301-982-5185

TECHNICAL SUMMARY

IN ACCOMPLISHING THE MISSIONS OF THE SCIENTIFIC AND APPLICATION SATELLITES, GSFC HAS BEEN CONFRONTED WITH THE PROBLEM OF EVER INCREASING DATA VOLUME AT THE SAME TIME THERE IS A GROWING REQUIREMENT FOR MORE SOPHISTICATED APPROACHES TO DATA-HANDLING AND PROCESSING. TWO OF THE MORE PROMISING AREAS OF INVESTIGATION WHICH SHOULD MAKE SIGNIFICANT CONTRIBUTIONS IN THE NEXT HALF-DECADE ARE: (1) FURTHER DEVELOPMENT OF ON-BOARD DATA PROCESSING TECHNIQUES IN WHICH NEW SEMICONDUCTOR TECHNOLOGY IS USED AS IT BECOMES AVAILABLE, E.G., COMPLEMENTARY MOSFET LARGE SCALE INTEGRATED (LSI) CIRCUITS; (2) DEVELOPMENT OF TECHNIQUES IN CODING, DECODING, AND GROUND DATA PROCESSING PLUS IMPROVEMENTS IN THE SPACECRAFT/GROUND STATION SYSTEM TO INCREASE THE EFFICIENCY AND ACCURACY OF SPACECRAFT CONTROL AND INFORMATION RETRIEVAL. OTHER AREAS UNDER STUDY WHICH SHOULD PRODUCE THEIR MOST SIGNIFICANT RESULTS IN THE MID-70'S INCLUDE: (3) OPTICAL DATA PROCESSING TECHNIQUES, AND (4) PATTERN RECOGNITION STUDIES MODELED FROM THE MAMMALIAN SYSTEM.



RTOP NO. 125-23-11 TITLE: ADVANCED IMAGE PROCESSING TECHNOLOGY FOR  
DEEP SPACE

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE OBJECTIVE IS TO ADVANCE THE STATE-OF-THE-ART IMAGE PROCESSING TECHNIQUES APPLICABLE TO BOTH GROUND-BASED AND SPACECRAFT SYSTEMS IN ORDER TO EFFICIENTLY EXTRACT AND PRESENT THE INFORMATION DESIRED BY THE USER. THIS IS NECESSARY IN ORDER TO UTILIZE THE INCREASINGLY LARGE VOLUMES OF IMAGING DATA BEING TRANSMITTED FROM DEEP SPACE AND EARTH ORBIT, AND SUBSEQUENTLY IN ORDER TO LOCATE MORE OF THE PROCESSING FUNCTIONS ON-BOARD RATHER THAN TRANSMITTING UNWANTED DATA. THIS PROGRAM EMPHASIZES RESEARCH IN SUPPORT OF NEEDS 3-10 YEARS IN THE FUTURE; I.E., FOR THE 1972-1979 TIME PERIOD. A CONTINUING STUDY TO DEFINE THE RELEVANT INFORMATION CONTENT AND ANTICIPATED QUANTITIES OF IMAGING DATA IS UNDERWAY. THESE REQUIREMENTS ARE TRANSLATED INTO LONG-RANGE SYSTEM FUNCTIONAL SPECIFICATIONS WHICH GUIDE THE NECESSARY SOFTWARE AND HARDWARE RESEARCH AND DEVELOPMENT. EMPHASIS IS PLACED UPON DEMONSTRATING THE FEASIBILITY OF AN APPROACH WHEREVER POSSIBLE, RATHER THAN PROTOTYPE HARDWARE FABRICATION. THE SOFTWARE RESEARCH WILL INCLUDE FIXED AND ADAPTIVE FILTERING ALGORITHMS, INFORMATION-PRESERVING AND DESTROYING ALGORITHMS, TRANSFORMATIONS SUCH AS FOURIER AND HADAMARD, ETC. THE HARDWARE EFFORTS WILL INCLUDE SPECIAL-PURPOSE PROCESSORS, MULTI-TONE INTERACTIVE DISPLAYS, MASS DATA FILE CONFIGURATION, AND HYBRID DIGITAL/OPTICAL TECHNIQUES. EMPHASIS WILL BE PLACED ON OPTIMUM SOFTWARE/HARDWARE COMBINATIONS AND THOSE SYSTEM CHARACTERISTICS UNIQUE TO TWO-DIMENSIONAL (IMAGERY) DATA PROCESSING.

RTOP NO. 125-23-12 TITLE: ADVANCED DIGITAL DATA SYSTEMS FOR DEEP  
SPACE

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

THE PURPOSE OF THIS TASK IS TO FORMULATE AND DEVELOP THEORETICAL TECHNIQUES FOR THE SYNTHESIS, ANALYSIS, AND FAULT DIAGNOSIS OF SPACECRAFT SCIENCE DATA PROCESSING SYSTEMS. THE SPACECRAFT DATA PROCESSOR IS TREATED AS FINITE-STATE MACHINE WHICH FALLS INTO THE DISCIPLINE OF AUTOMATA THEORY. INTERPLANETARY VOYAGES PLANNED FOR 1975-1978 REQUIRE SUBSYSTEMS TO BE OPERATIVE OVER A PERIOD OF YEARS. THIS TASK IS ALSO CONCERNED WITH THE DEVELOPMENT OF A VERY RELIABLE SPACECRAFT DIGITAL COMPUTERS USING EQUIPMENT REDUNDANCY. A COMPUTER IS BEING DEVELOPED WHICH AUTOMATICALLY ALLOCATES SPARE FUNCTIONAL UNITS TO REPLACE FAILED UNITS AND IS THUS SELF-REPAIRING UNTIL THE SPARES ARE EXHAUSTED. GIVEN SUCH A COMPUTER, IT CAN IN TURN BE EMPLOYED FOR MONITORING OTHER SUBSYSTEMS OF A SPACECRAFT AND EITHER REPLACING FAILED UNITS OR MITIGATING THE EFFECTS OF SUCH FAILURES TO THE OVERALL MISSION. THIS TASK WILL ALSO DEVELOP AND USE A FACILITY TO STUDY THE APPLICATION OF COMPUTER TECHNIQUES FOR THE AUTOMATION OF SCIENTIFIC INSTRUMENTS TO PERFORM LABORATORY EXPERIMENTS. THE GOAL IS TO DEVELOP HARDWARE AND SOFTWARE CONCEPTS WHICH CAN BE EXTENDED TO FLIGHT DIGITAL DATA SYSTEMS FOR ANY



FUTURE MISSIONS WHICH MAY REQUIRE AUTOMATED CONTROL AND ANALYSIS OF SCIENCE INSTRUMENTS. THE APPROACH IS TO USE A SMALL GENERAL PURPOSE DIGITAL COMPUTER IN CONJUNCTION WITH A VARIETY OF LAB INSTRUMENTS. THE EQUIPMENT MAY NOT BE NECESSARILY FLIGHT CONFIGURED, BUT THE RESEARCH GOALS WILL BE SPACECRAFT ORIENTED. THE INTERACTION BETWEEN COMPUTER AND INSTRUMENTS SUCH AS GCMS----

RTOP NO. 125-23-14 TITLE: SPACE STATION/BASE - ONBOARD CHECKOUT  
TECHNIQUES, SYSTEMS, AND SOFTWARE

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: MCCULLOUGH, C. E. TEL. 713-483-4162

TECHNICAL SUMMARY

THE PRESENT CONCEPT OF A SPACE STATION/BASE AS A PERMANENT FACILITY (10-YEAR LIFE) IMPLIES SELF-CONTAINED, AUTONOMOUS OPERATIONS. A SELF-CONTAINED BASE REQUIRES PERFORMING ONBOARD SOME FUNCTIONS WHICH WERE PREVIOUSLY PERFORMED ON THE GROUND SUCH AS STATUSING OPERATIONS, INTEGRATED SYSTEM CHECKOUT, ONBOARD, MAINTENANCE AND REPAIR, PROCESS CONTROL AND SCIENTIFIC PROCESSING. THE ONBOARD MAINTENANCE AND REPAIR CONCEPT DICTATES A REQUIREMENT FOR NEW SUBSYSTEM DESIGNS IN THE AREA OF REDUNDANCY, FAULT DETECTION, INFIGHT MAINTENANCE, AND REPAIR AND/OR REPLACEMENT. TO ACCOMPLISH AN INTEGRATED ONBOARD CHECKOUT APPROACH, STUDIES MUST BE INITIATED IN THE AREAS OF FLIGHT COMPUTER SYSTEM CHECKOUT AND STATUS MONITORING, REDUNDANT SYSTEM TECHNIQUE, SYSTEM SOFTWARE AND USER LANGUAGE REQUIREMENTS. THE ABOVE STUDIES WILL PROVIDE THE SPACE BASE THE CAPABILITY OF AUTONOMOUS CHECKOUT AND OPERATION OF ALL SYSTEMS. THIS WILL MINIMIZE CREW PARTICIPATION TO THE GREATEST PRACTICAL EXTENT IN ROUTINE SYSTEMS OPERATION THEREFORE MAXIMIZING MAN-HOURS AVAILABLE FOR SCIENTIFIC AND RESEARCH ENDEAVORS. A DEVELOPMENT ALONG THESE SAME LINES WILL BE IN EFFECT FOR THE SPACE SHUTTLE PROGRAM AND THAT EFFORT WILL BE CLOSELY FOLLOWED TO SEE IF THE HARDWARE/SOFTWARE TECHNOLOGY DEVELOPED WILL BE APPLICABLE TO THE BASE. THE EXISTING SPACE-QUALIFIED HARDWARE LACKS THE CAPABILITY, RELIABILITY AND FLEXIBILITY TO SATISFY THE SPACE STATION/BASE REQUIREMENTS.

RTOP NO. 125-23-16 TITLE: SPACE STATION OPTICAL MASS MEMORY ACCESS  
SYSTEM

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MCCULLOUGH, C. E. TEL. 205-453-1120

TECHNICAL SUMMARY

OBJECTIVE: FOR THE PAST SEVERAL YEARS, ONE MAJOR OBSTACLE PREVENTING THE LASER FROM ACHIEVING ITS ANTICIPATED POTENTIAL HAS BEEN THE LACK OF AN EFFICIENT, HIGH-SPEED, HIGH-RESOLUTION OPTICAL BEAM DEFLECTION SYSTEM. A PRIME APPLICATION OF A LASER BEAM DEFLECTION SYSTEM AND THE MAJOR OBJECTIVE OF THE EFFORT DESCRIBED BY THIS RTOP IS THE ACCESSING OF A MASS MEMORY ON THE ORDER OF  $5 \times 10^{12}$  BITS. THAT IS, A REQUIREMENT FOR OPTICALLY SCANNING SUCH A MEMORY TO READ-IN, READ-OUT, OR ERASE WILL EXIST IN THE TIME FRAME 1973-1980 FOR SPACE STATION/SPACE BASE. OTHER APPLICATIONS FOR LASER BEAM DEFLECTION TECHNIQUES INCLUDE: (1) ACQUISITION SCANNING OF OPTICAL

RADAR; (2) LINE SCANNING OF OPTICAL BEAMS FOR FILM RECORDING OF VIDEO TELEVISION OR RADAR SIGNALS; (3) HIGH-SPEED OSCILLOGRAPHY; (4) RASTER SCANNING OF LASER BEAMS FOR VIDEO SIGNAL GENERATION; (5) LINE SCANNING FOR LASER BEAM TELEVISION PROJECTION SYSTEMS; AND (6) A PERIODIC SCANNING FOR LASER SYMBOL PROJECTION. ALL OF THESE APPLICATIONS REQUIRE RAPID DEFLECTION, LOW LIGHT LOSS, LOW OPTICAL-PHASE FRONT DISTORTION, HIGH DEFLECTION ACCURACY AND MODERATELY LARGE LIGHT-POWER-HANDLING CAPABILITY. OTHER CRITERIA, WHICH VARY IN IMPORTANCE WITH APPLICATION, INCLUDE MAGNITUDE OF HORIZONTAL AND VERTICAL DEFLECTION, APERTURE DIAMETER, BANDWIDTH, DRIVE VOLTAGE, OPTICAL WAVE-LENGTH RANGE, DEGREE OF COLOR REGISTRATION, DEFLECTION LINEARITY, DEFLECTION RATE, AND ENVIRONMENTAL FACTORS. VARIOUS TECHNIQUES HAVE BEEN PROFERRED IN THE PAST, ALL OF WHICH DEPENDING ON SOME OPTO-MECHANICAL OR ELECTRO-OPTO-MECHANICAL PHENOMENA. THESE CAN BE CLASSIFIED GENERICALLY IN FOUR CATEGORIES: (1) VARIABLE REFLECTORS, (2) VARIABLE REFRACTORS,----

RTOP NO. 125-23-19 TITLE: MULTIPLEX DATA BUS TECHNIQUES FOR THE SPACE SHUTTLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MCCULLOUGH, C. E. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE IS TO STUDY AND DEVELOP THE NECESSARY COMPONENT TECHNOLOGY AND SYSTEM TECHNIQUES WHICH WILL LEAD TO THE SELECTION AND DEMONSTRATION OF A MULTIPLEX DATA BUS SYSTEM APPROPRIATE FOR SPACE SHUTTLE APPLICATION. DIFFERENT TECHNIQUES WILL BE STUDIED WITH EMPHASIS ON THE ASSOCIATED HARDWARE REQUIREMENTS, RELIABILITY, DATA BANDWIDTHS, AND FLEXIBILITY OF APPLICATION.

RTOP NO. 125-23-20 TITLE: SYSTEM AND COMPONENT TECHNOLOGY RELATED TO MASS DATA STORAGE FOR SPACE SHUTTLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MCCULLOUGH, C. E. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE BOTH THE COMPONENT TECHNOLOGY AND ASSOCIATED SYSTEM DEVELOPMENT FOR THE BULK DATA STORAGE REQUIREMENTS OF THE SPACE SHUTTLE. THE SELECTION OF A SUITABLE STORAGE COMPONENT IS DEPENDENT UPON THOSE FACTORS AFFECTING DATA TRANSFER RATES, RELIABILITY AND THE PHYSICAL CONSTRAINTS OF SIZE, WEIGHT AND POWER. A VARIETY OF TECHNIQUES ARE CURRENTLY IN EARLY PHASES OF DEVELOPMENT INCLUDING BOTH MOVING MEDIA AND SOLID STATE CONCEPTS. INITIAL EMPHASIS IS DIRECTED AT TRADE-OFF STUDIES TO SELECT THE MOST PROMISING TECHNOLOGY.

RTOP NO. 125-24-04 TITLE: ADVANCED AERODYNAMIC TEST/DEVELOPMENT  
FACILITY INSTRUMENTATION

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THIS RESEARCH IS NEEDED TO MEET FUTURE INSTRUMENTATION REQUIREMENTS FOR ADVANCED TEST FACILITIES BEING DEVELOPED FOR AERODYNAMIC RESEARCH AND TO PROVIDE IMPROVED GROUND-BASED MEASUREMENT TECHNIQUES FOR MEASURING CHARACTERISTICS OF THE ATMOSPHERE. THE SCOPE OF THE WORK EXTENDS FROM PRELIMINARY INVESTIGATIONS ON SUITABILITY OF MATERIALS FOR USE AS SENSING DEVICES TO DEVELOPMENT AND TESTING OF AN ACTUAL DEVICE. TYPICAL OBJECTIVES INCLUDE IMPROVED SOLID-STATE SENSORS FOR FORCE AND PRESSURE, HIGH SENSITIVITY IR DETECTORS, SENSITIVE SKIN-FRICTION MEASUREMENTS, ACCURATE ULTRA-HIGH VACUUM GAGES, MORE SENSITIVE FLOW VISUALIZATION TECHNIQUES, EXTEND CALIBRATION TECHNOLOGY TO RANGE BELOW  $10^{-9}$  TORR, IMPROVE DYNAMIC MEASUREMENTS, HIGH-TEMPERATURE STRAIN MEASUREMENTS AT TEMPERATURES ABOVE 1500 DEGREES F, FREE-STREAM VELOCITY MEASUREMENTS TO 45,000 FEET PER SECOND, SPATIALLY RESOLVED GAS DENSITY MEASUREMENTS OVER RANGE  $10^{-6}$  TO 1 ATMOSPHERE, IMPROVED ACCURACY IN PROBLESS ELECTRON BEAM TECHNIQUES FOR TEMPERATURE MEASUREMENTS, USE OF RADIATION ACTIVATION AND TRACER TECHNIQUES TO AERODYNAMIC TESTING PROBLEMS, DEVELOPMENT OF GROUND-BASED LASER RADAR DIAGNOSTIC PROBE TECHNIQUES FOR APPLICATION TO DENSITY PROFILE MEASUREMENTS IN EARTH'S ATMOSPHERE, TURBULENCE MEASUREMENTS IN HIGH VELOCITY AIR FLOW, AND DETECTION OF AEROSOL CONCENTRATIONS WHICH HAVE BEEN ASSOCIATED WITH CLEAR-AIR TURBULENCE.

RTOP NO. 125-24-05 TITLE: ADVANCED ATMOSPHERIC AND REMOTE  
MEASUREMENT TECHNIQUES FOR AEROSPACE  
PROGRAMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

ADVANCED MEASUREMENT TECHNIQUES ARE BEING DEVELOPED FOR AEROSPACE MISSIONS WHICH INVOLVE ATMOSPHERIC ENTRY AND LANDING. PROPOSED SENSORS INCLUDE GAMMA-RAY BACK SCATTER AND ALPHA PARTICLE TECHNIQUES FOR MEASURING ATMOSPHERIC DENSITY; HEAT SHIELD ABLATION SENSORS; THIN FILM THERMISTORS FOR MEASURING ATMOSPHERIC TEMPERATURE; MINIATURE REMOTE ATTACHMENT DEVICES FOR MEASURING PERFORMANCE CHARACTERISTICS OF PARACHUTES; AND MULTISPECTRAL IMAGING SYSTEMS FOR SURVEYING THE CHEMISTRY OF PLANETARY SURFACES OR REMOTE DETECTION OF EARTH RESOURCE TARGETS.

RTOP NO. 125-24-06 TITLE: ADVANCED SPACE INSTRUMENTATION

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: DIMEFF, J. TEL. 415-961-1111

TECHNICAL SUMMARY

INSTRUMENTATION TECHNIQUES WILL BE DEVELOPED FOR MEASURING FIELDS, PARTICLES AND RADIATION FOR APPLICATION TO FUTURE SPACE

MISSIONS. TYPICAL EFFORTS WILL BE DIRECTED TO MEASUREMENT OF RADIATION FROM THE FAR IR TO UV WITH EMPHASIS ON IMPROVEMENT OF PHOTO-MULTIPLIERS AND THERMAL DETECTORS AND MEASUREMENT OF INTERPLANETARY SPACE WITH EMPHASIS ON THE DEVELOPMENT OF MAGNETOMETERS AND PARTICLE DETECTORS. AUTOMATED INSTRUMENT SYSTEMS WILL BE DEVELOPED FOR ANALYSIS OF PLANETARY ENVIRONMENT, PHYSICAL AND CHEMICAL PARAMETERS, AND POSSIBLE LIFE FORMS.

RTOP NO. 125-24-07 TITLE: ADVANCED AEROSPACE MEASUREMENT METHODS  
(AERONAUTICAL/LIFE SCIENCES AND TEST FACILITIES)

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: DINEFF, J.

TEL. 415-961-1111

TECHNICAL SUMMARY

ADVANCED INSTRUMENTS AND NEW TECHNIQUES WILL BE DEVELOPED TO SUPPORT AERONAUTICS AND LIFE SCIENCE RESEARCH IN AMES FLIGHT AND GROUND TEST FACILITIES AND TO UPGRADE THE CAPABILITY AND PERFORMANCE OF THESE FACILITIES. ADVANTAGE WILL BE TAKEN OF NEW TECHNOLOGICAL DEVELOPMENTS, FOR EXAMPLE, LASERS WILL BE UTILIZED IN PHOTOGRAPHY, GAS FLOW VISUALIZATION, AND TURBULENCE STUDIES INCLUDING HOLOGRAPHIC TECHNIQUES AND OPTICAL SPATIAL FILTERING. INSTRUMENTATION WILL BE DEVELOPED TO MEASURE THE RADIATION FROM, AND TO DETECT AND PHOTOGRAPH, HIGH VELOCITY PARTICLES AND MODELS BEING TESTED IN WIND TUNNELS AND SHOCK TUNNELS. TELEMETRY TECHNIQUES WILL BE DEVELOPED FOR TRANSMISSION OF DATA FROM FREE FLIGHT MODELS IN WIND TUNNELS AND OTHER TEST FACILITIES AND FOR BIOMEDICAL APPLICATIONS IN HUMAN AND ANIMAL SUBJECTS. DEVELOPMENT OF FORCE AND PRESSURE MEASURING INSTRUMENTS AND CALIBRATING TECHNIQUES WILL BE CONTINUED FOR EXTREME HIGH AND LOW SPEED AERODYNAMIC PHENOMENA IN SIMULATED PLANETARY ATMOSPHERIC ENVIRONMENTS. MICROWAVE DIAGNOSTIC TECHNIQUES FOR MEASURING HIGH TEMPERATURE GAS PROPERTIES SUCH AS ELECTRON DENSITY, COLLISION FREQUENCY, ELECTRON RECOMBINATION RATES, AND CONCENTRATIONS OF SPECIFIC SPECIES WILL BE DEVELOPED. MORE SENSITIVE ELECTROMETERS WILL BE DEVELOPED FOR MEASURING VERY LOW CURRENTS, ALONG WITH BETTER METHODS OF MINIATURIZING CIRCUITS AND DEVELOPING INTEGRATED CIRCUIT TECHNIQUES.

RTOP NO. 125-24-09 TITLE: ADVANCED INSTRUMENTATION TECHNIQUES FOR  
IMAGING AND REMOTE SENSING

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: BARRINGTON, A. E. TEL. 617-494-2571

TECHNICAL SUMMARY

A BROAD PROGRAM WILL BE PURSUED FOR DEVELOPMENT OF EVALUATION TECHNIQUES FOR ADVANCED SENSORS AND TECHNIQUES ESSENTIAL TO MAKING REMOTE MEASUREMENTS REQUIRED BY FUTURE SPACE AND AERONAUTICS PROGRAMS; SPECIFICALLY, MULTISPECTRAL SENSORS AND SOLID-STATE-ARRAY IMAGING-SYSTEMS FOR EARTH SURVEYS WILL BE EVALUATED, EXTREME-ULTRAVIOLET AND SOFT X-RAY SENSORS FOR SOLAR AND STELLAR OBSERVATIONS, AND ULTRASONIC AND FLUIDIC TRANSDUCERS FOR AVIONICS AND BIOTECHNOLOGY PROGRAMS WILL BE DEVELOPED.

RTOP NO. 125-24-10 TITLE: INSTRUMENTATION AND DATA DISPLAY FOR  
SPACE ENVIRONMENTAL TESTING

ORGANIZATION: GODDARD SPACE FLIGHT CTR.

MONITOR: WILSON, M. W. TEL. 301-982-4181

TECHNICAL SUMMARY

THIS RESUME COMBINES SEVERAL TASKS WHICH ARE CURRENTLY IN PROGRESS AT GSFC. WORK COVERED BY THESE TASKS INCLUDES: DEVELOPMENT OF METHODS TO MEASURE EXTREMELY LOW RADIATION LEVELS AND TO PROVIDE MORE ACCURATE MEANS OF CALIBRATION IN THE ULTRAVIOLET REGION; DEVELOPMENT OF INSTRUMENTATION SYSTEMS TO DETECT AND MEASURE DISTORTION OR TILT DUE TO TEST CONDITIONS, TO MEASURE CONTAMINATION, TO MAKE NONCONTACTING TEMPERATURE MEASUREMENTS OF SPACECRAFT SYSTEMS UNDER ENVIRONMENTAL TEST, TO MEASURE OPTICAL PROPERTIES OF MATERIALS IN SPACE ENVIRONMENT, AND TO PROVIDE FOR COMPUTER CONTROL OF SPECIALIZED TEST OPERATIONS; DEVELOPMENT OF EQUIPMENT AND TECHNIQUES TO PROVIDE RAPID COLLECTION, PROCESSING, AND DISPLAY OF TEST DATA. INSTRUMENTATION DEVELOPMENTS IN LATER YEARS WILL PROVIDE FOR THE SPECIAL NEEDS OF SIMULATION FOR SPACE PROGRAMS INVOLVING HIGHER SOLAR INTENSITIES AND EXTENDED LIFETIMES.

RTOP NO. 125-24-11 TITLE: INSTRUMENTATION FOR ADVANCED LAUNCH  
ENVIRONMENTAL TEST AND OPERATIONS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: WILSON, M. W. TEL. 205-453-1120

TECHNICAL SUMMARY

NEW OR IMPROVED SENSORS WILL BE DEVELOPED SO THAT TEMPERATURE AND HUMIDITY PROFILES CAN BE MEASURED SIMULTANEOUSLY WITH DETAILED WIND PROFILES. THIS WILL ENABLE REAL TIME PREDICTION OF LAUNCH CONDITIONS, THUS GREATLY IMPROVING LAUNCH DECISIONS WHILE REDUCING COST. ALSO TO BE DEVELOPED AND EVALUATED WILL BE NEW FLUID FLOW MEASUREMENT DEVICES, A CROSSED BEAM SPECTROMETER FOR THE DETECTION OF LOCAL RADIATION PHENOMENA, AND IMPROVED SOLID STATE IMAGING DEVICES.

RTOP NO. 125-24-12 TITLE: ADVANCED INSTRUMENT TECHNOLOGY FOR  
INTERPLANETARY SPACECRAFT/TEST FACILITIES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-534-6586

TECHNICAL SUMMARY

ONE OF THE LONG RANGE OBJECTIVES OF THIS TASK IS TO CONCEIVE, DESIGN, DEVELOP AND DEMONSTRATE SIGNAL CONDITIONING CIRCUITRY HAVING APPLICATION TO PLANETARY ORBITING AND LANDED SCIENTIFIC INSTRUMENTATION. CHARACTERISTIC OF SUCH CIRCUITS WILL BE LOW DRIFT, FAST RESPONSE, HIGH RELIABILITY AND LONG LIFE. THE IMMEDIATE OBJECTIVES FOR FY'70 ARE IN SUPPORT OF GAS CHROMATOGRAPH MASS SPECTROMETER LIFE DETECTION INSTRUMENT, (GS/MS), AND MASS SPECTROMETRY INSTRUMENTATION. THIS EFFORT INCLUDES A CHARGED PARTICLE COUNTING TECHNIQUES, A POWER LAW COMPRESSION TECHNIQUE, A GC/MS SIGNAL NORMALIZATION METHOD A METHOD FOR COMPENSATING MASS SPECTROMETER TRANSMISSION EFFICIENCY VARIATION, AND THE MICROMINUTORIZATION OF A LOGARITHMIC ELECTROMETER IN HYBRID FORM. THE COUNTING TECHNIQUES

WILL FIND PRIMARY APPLICATION TO ATMOSPHERIC ANALYSIS. THE OTHER ACTIVITIES HAVE APPLICATION TO THE MARS AND VENUS ATMOSPHERIC MASS SPECTROMETER AND GC/MS INSTRUMENTS. AN ADDITIONAL OBJECTIVE IS TO DEVELOP HIGH ACCURACY TOTAL RADIATION RADIOMETRIC INSTRUMENTS FOR ALL LEVELS OF IRRADIANT ENERGY AS RELATED TO SPACECRAFT TESTING. A HIGH DEGREE OF ACCURACY IS REQUIRED FOR THE MEASUREMENT OF SIMULATED SOLAR RADIATION FOR THE TESTING OF SPACECRAFT. PRIMARY STANDARDS FOR IRRADIANCE MEASUREMENT ARE BEING DEVELOPED WHOSE ACCURACY IS OF THE DEGREE REQUIRED FOR SPACECRAFT TESTING. THESE STANDARDS WILL BE APPLICABLE TO ALL USES REQUIRING AN ABSOLUTE SCALE OF REFERENCE FOR TOTAL IRRADIANCE. THE WORK AT THE PRESENT STAGE CONSISTS OF UTILIZING THE CAVITY----

RTOP NO. 125-24-14 TITLE: AIRCRAFT HAZARDS AVOIDANCE TECHNIQUES AND  
ADVANCED COMPONENTS

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: ROBERTS, L. W. TEL. 617-494-2028

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO IDENTIFY SOME OF THE PHYSICAL CHARACTERISTICS ASSOCIATED WITH HIGH-ALTITUDE CLEAR AIR TURBULENCE (CAT), TO DEVISE ELECTROMAGNETIC INSTRUMENTS FOR THE REMOTE DETECTION OF ONE OR MORE OF THESE CHARACTERISTICS, AND TO DEVELOP PHENOMENOLOGICAL MODELS OF CAT WHICH WILL PERMIT THE LOGICAL AND/OR MICROWAVE DATA TO BE TRANSFORMED INTO A DISPLAY OUTPUT OF RANGE AND SEVERITY OF A DETECTED CAT EVENT. SINCE ONE OF THE MOST ACCESSIBLE METEOROLOGICAL PARAMETERS THAT SEEMS TO BE ASSOCIATED WITH CAT IS A TEMPERATURE ANOMALY, THE PASSIVE DETECTION OF AND RANGING ON EACH ANOMALIES USING MILLIMETER WAVE TECHNIQUES WILL BE ONE OF THE SHORT TERM GOALS OF THE PROGRAM. IF SUCCESSFUL THE RESULTS OF THIS TEST PROGRAM COULD BE OF IMMEDIATE BENEFIT TO HIGH-ALTITUDE JET AIRCRAFT.

RTOP NO. 125-24-16 TITLE: AIRCRAFT FLIGHT TEST AND OPERATIONS  
INSTRUMENTATION TECHNOLOGY

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: SANDERSON, K. C. TEL. 805-258-3311

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO DEVELOP PRECISION SENSORS AND SIGNAL CONDITIONING TO MEASURE RESEARCH AIRCRAFT PARAMETERS AT SUPERSONIC SPEEDS. IN GENERAL, ANGLE OF ATTACK, ANGLE OF SIDESLIP, AND STAGNATION TEMPERATURE MEASUREMENTS AT HIGH SPEEDS, HIGH TEMPERATURE STRAIN AND BOUNDARY LAYER DENSITY MEASUREMENTS, ANGULAR ACCELERATION AND VELOCITY MEASUREMENTS, ATTITUDE AND ACCELERATION MEASUREMENTS IN TURBULENCE, AND ADVANCED DIGITAL DATA SYSTEMS FOR DATA GATHERING, MALFUNCTION DETECTION, AND FAILURE-WARNING AND ANALYSIS ARE PROBLEMS OF INTEREST. LIKELY APPLICATIONS WOULD BE ON SUPERSONIC AIRCRAFT SUCH AS THE YF-12, AND THE SPACE SHUTTLE.



RTOP NO. 125-24-17 TITLE: INSTRUMENTATION FOR INTERMEDIATE SIZE  
DIFFRACTION LIMITED SPACE TELESCOPES

ORGANIZATION: GODDARD SPA. FLGT. CENTER

MONITOR: KUPPERIAN, J. E. TEL. 301-982-5101

TECHNICAL SUMMARY

DEVELOP ASTRONOMICAL INSTRUMENTATION SUI TABLE FOR USE WITH ONE METER CLASS DIFFRACTION LIMITED SPACE TELESCOPES. SPECIFIC OPTICAL SUBSYSTEMS SUCH AS LARGE CONCAVE GRATINGS AND ADVANCED SYSTEMS FOR IMAGE DETECTION TO ACHIEVE BASIC ASTRONOMICAL MEASUREMENTS, WITH PRIMARY EMPHASIS ON THE 1050 TO 8500 A REGION, WILL BE DEVELOPED.

RTOP NO. 125-24-18 TITLE: ELECTRONIC TECHNOLOGY FOR EARTH SURVEYS

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: LARSON, G. S. TEL. 617-494-2300

TECHNICAL SUMMARY

A BROAD PROGRAM WILL BE PURSUED TO ESTABLISH ELECTRONIC TECHNOLOGY REQUIREMENTS FOR EARTH SURVEYS AND TO PROVIDE A CONTINUOUSLY UP-DATED DEVELOPMENT PLAN FOR THE ELECTRONICS RESEARCH CENTER. THE TECHNOLOGY-REQUIREMENTS WILL BE MAINLY IN THE AREAS OF ELECTROMAGNETIC SENSING ON-BOARD DATA-PROCESSING, DATA-TRANSMISSION AND COMMUNICATIONS, GROUND DATA-PROCESSING, AND ATTITUDE-DETERMINATION. EFFORTS WILL BE DIRECTED SPECIFICALLY TO INTEGRATED SENSING AND ON-BOARD DATA-PROCESSING SYSTEMS FOR ADVANCED MULTISPECTRAL-IMAGING REQUIREMENTS OF OPERATIONAL EARTH SURVEYS SATELLITES AND AIRCRAFT, OPTIMUM USE OF THE ELECTROMAGNETIC SPECTRUM FOR TRANSMISSION OF DATA, GROUND-BASED DATA-PROCESSING OF EARTH-SURVEYS INFORMATION ATTITUDE-DETERMINATION SYSTEMS TO BE USED IN IMAGE-RECONSTRUCTION.

RTOP NO. 125-24-19 TITLE: SPACE SHUTTLE SENSORS AND INSTRUMENTATION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: LARSON, G. S. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OPERATIONAL REQUIREMENTS OF THE SPACE SHUTTLE VEHICLE WILL REQUIRE MEASUREMENTS BEYOND THE CAPABILITY OF PRESENT TECHNOLOGY. SPECIFICALLY, ZERO "G" QUANTITY MEASUREMENTS, SLUSH CRYOGENIC INSTRUMENTATION, AND AIR DATA SENSORS ARE THE TECHNOLOGY AREAS REQUIRING ADVANCEMENT. THE TECHNOLOGY IN THE ABOVE AREAS WILL BE MAINLY AN EXTENSION OF ON-GOING RESEARCH REORIENTED TO THE REQUIREMENTS OF THE SPACE SHUTTLE.

RTOP NO. 125-24-20 TITLE: EARTH ORBIT LOGISTICS - SENSORS AND  
INSTRUMENTATION

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: SMITH, D. R. TEL. 713-483-3071

TECHNICAL SUMMARY

THE AIR DATA INSTRUMENTATION SYSTEM REQUIRED TO SUPPORT THE STS (SPACE TRANSPORTATION SYSTEM) WILL BE DEFINED. ANY NEW TECHNOLOGY



WILL BE IDENTIFIED, AND THE BEST TECHNIQUE OF BUILDING AIR DATA SENSORS THAT WILL MEET THE STS REQUIREMENTS WILL BE EXPLORED AND EVALUATED TO DEFINE THE BEST TECHNOLOGY OPTIONS. A MEASURING TECHNIQUE CAPABLE OF ACCURATELY MONITORING FLUID QUANTITIES WHILE THEY ARE EXPOSED TO A ZERO G ENVIRONMENT WILL ALSO BE DEVELOPED TO SUPPORT THE STS PROGRAM. THE DEVELOPMENT WILL INVOLVE REQUIREMENTS AND TECHNIQUES TRADE-OFF STUDIES PERFORMED BY INDUSTRIAL SPECIALISTS AND ENGAGE IN HARDWARE DEVELOPMENT THROUGH CONTRACTS TO INDUSTRY LEADING TO OPERATIONAL CONFIGURED HARDWARE WHICH WILL SUPPORT THE STS PROGRAM. PRESENT AIR DATA SENSORS AND LIQUID QUANTITY MEASURING SYSTEMS ARE NOT RELIABLE ENOUGH TO SUPPORT THE STS. SOME OF THE SENSORS ARE NOT BUILT TO WITHSTAND THE RE-ENTRY ENVIRONMENTS AND NONE OF THEM COULD REALIZE INTERFACE WITH THE VEHICLES CORE AVIONICS SYSTEM. THE LIQUID QUANTITY SENSORS AND ASSOCIATED ELECTRONICS USED ON PRESENT SPACECRAFT ARE NOT DESIGNED TO FUNCTION UNDER ZERO G CONDITIONS.

RTOP NO. 125-24-21 TITLE: STUDY OF A VEHICLE STATUS AND MONITORING CONCEPT

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: LOVE, J. E. TEL. 805-258-3311

TECHNICAL SUMMARY

A STATE-OF-THE-ART SYSTEM DESIGNED FOR MONITORING AND CONTINUOUS IN-FLIGHT RECORDING OF PARAMETERS WHICH DETERMINE THE OPERATIONAL STATUS OF A VEHICLE WILL BE FLIGHT TESTED IN A HIGH PERFORMANCE JET AIRCRAFT. AFTER EACH FLIGHT, A QUICK ANALYSIS IS PERFORMED BY COMPUTER PROCESSING OF THE DIGITIZED MAGNETIC FLIGHT TAPE. OPERATIONAL DISCREPANCIES ARE DETECTED AND IDENTIFIED WHEN SENSED QUANTITIES EXCEED PREDETERMINED THRESHOLDS AS INSERTED INTO THE COMPUTER FOR ANALYSIS. THE TAPE ALSO SERVES AS A HISTORY OF OPERATION FROM WHICH PREDICTIONS OF MALFUNCTION OR FAILURE CAN BE MADE FROM LONG-TERM (SEVERAL HUNDRED HOURS OF FLIGHT) PARAMETRIC TREND ANALYSIS. THE FLIGHT EXPERIENCE AND DATA ACCUMULATED WILL PROVIDE BASIC INFORMATION FOR SYSTEM REQUIREMENTS FOR THE SPACE SHUTTLE VEHICLE TO ACHIEVE SHORT TURNAROUND TIME BY AUTOMATIC SYSTEM TESTING, FAULT LOCATION, AND CHECKOUT.

RTOP NO. 125-25-05 TITLE: THICK FILM TECHNOLOGY - MATERIALS, PROCESSING, AND TEST

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: MOORE, W. M. TEL. 703-827-3631

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO INVESTIGATE MATERIALS, DEVICES, AND SYSTEMS FOR SPECIALIZED ELECTRONIC INSTRUMENTATION FOR AIRCRAFT, SPACECRAFT, AND OTHER RESEARCH VEHICLES. A SIGNIFICANT AMOUNT OF THIS WORK IS DIRECTED TO THE DEVELOPMENT OF INSTRUMENTATION WHICH MAY USE ONE-OF-A-KIND ELECTRONICS IN UNUSUAL ENVIRONMENTS WITH EMPHASIS ON SMALL SIZE AND WEIGHT, ACCURACY, STABILITY, AND POWER CONSUMPTION. MOST OF THE SPECIALIZED CIRCUIT DEVELOPMENT IS BASED ON THICK FILM TECHNOLOGY, WITH SUPPORTING R&D IN INTEGRATED CIRCUITS.

THE WORK ALSO INCLUDES TASKS IN LINE QUALIFICATION OF INTEGRATED CIRCUITS THROUGH STEP STRESS ANALYSIS, AND THE DEVELOPMENT OF REMOTE ATTACHMENT TELEMETRY TECHNIQUES UTILIZING HYBRID MICROELECTRONIC CONCEPTS.

RTOP NO. 125-25-06 TITLE: MATERIALS RESEARCH FOR ELECTRONIC DEVICES  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: WARSCHAUER, D. M. TEL. 617-494-2510  
TECHNICAL SUMMARY

MATERIALS USED IN SOLID-STATE DEVICES HAVING ELECTRONICALLY ACTIVE FUNCTIONS, SUCH AS AMPLIFICATION, INFORMATION STORAGE, MICROWAVE GENERATION, MODULATION, AND THE LIKE MUST BE IMPROVED AND NEW MATERIALS DEVELOPED. THE WORK IS CATEGORIZED UNDER FOUR GENERAL HEADINGS: NEW MATERIALS AND MATERIAL IMPROVEMENT; CONTROL OF CHARACTERISTICS; HIGH TEMPERATURE MATERIALS; PROCESS DEVELOPMENT. THIN FILM AND BULK SEMICONDUCTORS, DIELECTRIC, ELECTRO-OPTIC, AND MAGNETIC MATERIALS ARE FABRICATED, AND ANALYZED WITH A VIEW TO ANTICIPATING NASA'S DEVICE NEEDS AND SOLVING CURRENT PROBLEMS.

RTOP NO. 125-25-07 TITLE: ADVANCED COMPONENT RESEARCH AND DEVELOPMENT  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: ROTH, H. TEL. 617-494-2329  
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS PROGRAM IS TO SATISFY NASA'S NEED FOR A FULLY COMPATIBLE AND INTEGRATED SPECTRUM OF ELECTRONIC COMPONENTS QUALIFIED TO PERFORM UNDER STRINGENT AND UNIQUE CONDITIONS IMPOSED BY THE AEROSPACE ENVIRONMENT. SUCH AN OBJECTIVE REQUIRES A CLOSELY COORDINATED RESEARCH AND DEVELOPMENT EFFORT IN THE FOLLOWING KEY FUNCTIONAL COMPONENT ARE AS: 1) SIGNAL GENERATORS AND DETECTORS; 2) SIGNAL PROCESSING ELEMENTS; 3) ENVIRONMENTAL SENSORS AND TRANSDUCERS; 4) ADAPTIVE AND STORAGE ELEMENTS; AND 5) DISPLAY DEVICES. IN ADDITION TO THE FUNCTIONAL REQUIREMENTS, THE FOLLOWING CONDITIONS MUST BE SATISFIED IN ACCORDANCE WITH MISSION OBJECTIVES: 1) LONG-LIFE, UP TO TEN YEARS AND MORE; 2) TOLERANCE TO TEMPERATURE EXTREMES, UP TO 500 DEGREES C OR DOWN TO CRYOGENIC TEMPERATURES; 3) RESISTANCE TO MECHANICAL SHOCK AND VIBRATION; 4) RADIATION TOLERANCE; AND 5) SMALL VOLUME, WEIGHT, AND POWER DISSIPATION. TO ACHIEVE THE CENTRAL OVERALL OBJECTIVE OF A BROAD, INTEGRATED, AEROSPACE-QUALIFIED ARSENAL OF ACTIVE AND PASSIVE ELECTRONIC COMPONENTS, KEY RESEARCH AND DEVELOPMENT TASKS WILL BE CAREFULLY SELECTED IN COORDINATION WITH CONCURRENT MATERIALS, BASIC PHYSICS, AND SYSTEMS EFFORTS.

RTOP NO. 125-25-08 TITLE: DESIGN PROCESSING AND TESTING OF LSI  
ARRAYS FOR FLIGHT COMPUTER

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: HAPP, W. W. TEL. 617-494-2351

TECHNICAL SUMMARY

OBJECTIVES: FABRICATE AND EVALUATE SOLID STATE LOGIC MODULES FOR ELECTRONIC SUBSYSTEMS SPECIFICALLY: (1) DEVELOP TECHNOLOGY FOR FABRICATING MOS/LSI DEVICES CONTAINING MORE THAN 500 ELEMENTS PER CHIP; (2) DESIGN AND IMPLEMENT AUTOMATED TEST EQUIPMENT INCLUDING SOFTWARE TO PERFORM SEQUENTIAL AND COMBINATIONAL TESTS ON ARRAYS WITH 20-200 PINS; (3) IMPROVE MASK FABRICATION MODULAR LOGIC CONFIGURATION AND MULTILEVEL INTERCONNECTION TO ACHIEVE HIGHER RELIABILITY, LOWER POWER CONSUMPTION, GREATER FUNCTIONAL COMPLEXITY AND BETTER NOISE IMMUNITY. APPLICATIONS: APPLICABLE TO ALL SOLID STATE SYSTEMS, SPECIFICALLY ARRAYS IN CONSTRUCTING COMPUTER AND GUIDANCE HARDWARE. THE DEVELOPMENT IS INTENDED FOR, BUT NOT LIMITED TO, A FLIGHT COMPUTER OF MODULAR DESIGN. APPROACH: A THREE-YEAR EFFORT IS PLANNED, DURING THE INITIAL YEAR THE FOLLOWING OBJECTIVES ARE TO BE ACCOMPLISHED. (SEE P. 2, ITEM 12)

RTOP NO. 125-25-09 TITLE: RELIABILITY & QUALITY ASSURANCE  
TECHNIQUES FOR ELECTRONIC COMPONENTS

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: WATT, C. W. TEL. 617-494-2450

TECHNICAL SUMMARY

OBJECTIVES: TO DEVELOP NEW AND IMPROVED APPROACHES TO RELIABILITY AND QUALITY ASSURANCE FOR COMPONENTS IN LONG LIVED APPLICATIONS WITH PARTICULAR EMPHASIS ON METHODS AND TECHNIQUES APPLICABLE TO LARGE SCALE INTEGRATED DEVICES. APPLICATION: TOPS PROGRAM, ATM AND SPACECRAFT IN GENERAL. APPROACH: WORK WILL BE DONE ON (1) WORKMANSHIP STANDARDS (2) SCREENING STUDIES (3) NEW APPROACHES TO QUALIFICATION OF LSI DEVICES (4) FAILURE MECHANISMS AND FAILURE ANALYSIS STUDIES USING NEW AND ADVANCED INSTRUMENTATION TECHNIQUES (5) IN-PROCESS TEST AND EVALUATION TECHNIQUES.

RTOP NO. 125-25-10 TITLE: ELECTRONIC COMPONENT DEVELOPMENT FOR  
SPACE CRAFT APPLICATION AND SUPPORT

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: KAMBOURIS, G. N. TEL. 301-982-4573

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO ASSURE THE AVAILABILITY OF ELECTRONIC COMPONENTS WHICH WILL MEET FUTURE GSFC SPACECRAFT AND APPLICATION NEEDS. MEETING THESE NEEDS WILL REQUIRE THE DEVELOPMENT OF COMPONENTS HAVING LOWER POWER DISSIPATION, SIZE, WEIGHT AND COST CHARACTERISTICS, LONGER LIFE, HIGHER TEMPERATURE AND RADIATION TOLERANCES, FASTER RESPONSE AND DATA HANDLING CAPABILITIES, IMPROVED RELIABILITY, ETC. TO ACCOMPLISH THIS, A PROGRAM TO INVESTIGATE, DEVELOP AND APPLY ADVANCED TECHNOLOGY AND TECHNIQUES WILL BE IMPLEMENTED IN THE COMPONENT RELATED AREAS OF DESIGN, MATERIALS, FABRICATION, TESTING, APPLICATIONS, AND RELIABILITY. SPECIFICALLY,

THE PROGRAM WILL CONSIST OF SUCH EFFORTS AS DEVELOPING: METAL-INSULATOR SEMICONDUCTOR (MIS) DEVICES TO TAKE ADVANTAGE OF AN INDICATED INCREASE IN RADIATION AND TEMPERATURE TOLERANCE; HYBRID CIRCUITS AND CUSTOM BUILT MEDIUM SCALE (MSI) AND LARGE SCALE (LSI) INTEGRATED CIRCUITS TO IMPROVE SYSTEM RESPONSE TIME AND DATA HANDLING CAPABILITIES; POLYMERIC MATERIALS WITH MODIFIED MOLECULAR STRUCTURE TO IMPROVE THERMAL CONDUCTIVITY; HYBRID MICROCIRCUIT TECHNIQUES WHICH COULD RESULT IN RF AMPLIFIERS OPERATING AS HIGH AS 2 GHZ; TESTING TECHNIQUES, ENVIRONMENTAL SIMULATION, SENSORS, AND EQUIPMENTS NECESSARY FOR EFFECTIVE DETERMINATION OF COMPONENT RELIABILITY.

RTOP NO. 125-25-11 TITLE: ELECTRONIC COMPONENT PACKAGING AND INTERCONNECTION R & D

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-6586

TECHNICAL SUMMARY

TO ACHIEVE LONG LIFE SPACECRAFT ELECTRONIC SYSTEMS ACCEPTABLE PACKAGING DENSITIES AND ENVIRONMENTAL REQUIREMENTS NECESSITATES THE DEVELOPMENT OF NEW PACKAGING AND INTERCONNECTION TECHNIQUES. THE OBJECTIVE OF THE WORK IS TO SATISFY THESE REQUIREMENTS IN THE TECHNOLOGY AREAS OF MICROELECTRONIC INTERCONNECTIONS, HYBRID PACKAGING, AND ELECTRONIC CABLING. DEVELOPMENT WILL BE CONTINUED IN THE FOLLOWING: COMPONENT, CIRCUIT AND MODULE CONNECTIONS; COMBINING THICK FILM, THIN FILM AND MONOLITHIC COMPONENTS AND CONNECTIONS FOR HYBRID CIRCUITS; CHOOSING APPROPRIATE PLASTIC MATERIALS AND APPLICATION METHODS FOR PROTECTION OF ELECTRONIC COMPONENTS AND MODULES; AND A CONCEPT OF ASSEMBLY AND SUBASSEMBLY PACKAGING AND CABLING WHICH IS ADAPTABLE TO SIZE ADJUSTMENTS. FUTURE NARA MISSIONS REQUIREMENTS AND CONCEPTS ARE TO BE EXAMINED AT THE EXTREMES OF ENVIRONMENTAL CONDITIONS IN ORDER TO DEVELOP THE THERMAL CRITERIA AGAINST WHICH, 1) ELECTRONICS PIECE PARTS MUST PERFORM, AND 2) IMPROVED THERMAL CONTROL OR PACKAGING TECHNIQUES ARE REQUIRED. THIS EFFORT WILL DEFINE THE ADEQUACY OF EXISTING KNOWLEDGE (OR CAPABILITY) OF ELECTRONIC PARTS, AGAINST THE CRITERIA DEFINED, IN ORDER TO PROVIDE AN INDICATION OF WHICH PARTS REQUIRE FURTHER STUDY AND DEVELOPMENT. DEVELOPMENT IN THE TECHNOLOGY OF HIGH VOLTAGE PACKAGING WILL BE CONTINUED TO ESTABLISH MATERIAL CALLOUTS, HARDWARE GEOMETRICS AND PROCESS PROCEDURES SUCH THAT HIGH VOLTAGE CIRCUITS MAY BE DESIGNED AND FABRICATED TO OPERATE WITHOUT BREAKDOWN IN HOSTILE ENVIRONMENTAL CONDITION. THE FEASIBILITY OF A SOLID STATE TRIODE HAS BEEN DEMONSTRATED IN PREVIOUS WORK. THE OBJECTIVE IS TO ADVANCE THIS DEVICE TO A QUALIFIED COMPONENT THAT CAN BE USED IN SPACECRAFT SUBSYSTEMS.

RTOP NO. 125-25-12 TITLE: ELECTRONIC COMPONENT SCREENING & QUALIFICATION DEVELOPMENT

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: POWELL, R. V. TEL. 213-354-3586

TECHNICAL SUMMARY

TO EFFECTIVELY UTILIZE MICROELECTRONIC DEVICES OF MSI/LSI

COMPLEXITY IN FUTURE SPACECRAFT ELECTRONIC SYSTEMS, MAJOR TECHNOLOGICAL AREAS MUST BE DEVELOPED. THESE AREAS INCLUDE PRIME RELIABILITY ORIENTED TOPICS SUCH AS FAILURE MECHANISMS, RADIATION RESISTANCE AND APPROACHES TO QUALIFICATION AND SCREENING METHODOLOGY. INDUSTRY IN GENERAL DEVELOPS AND MANUFACTURES ELECTRONIC DEVICES FOR APPLICATION WITH LESS STRINGENT RELIABILITY REQUIREMENTS THAN THOSE OF FUTURE SPACECRAFT MISSIONS. THE OBJECTIVE OF THIS TASK IS TO ESTABLISH A TECHNICAL FOUNDATION WHICH WILL 1) PERMIT THE DEVELOPMENT OF TECHNIQUES FOR THE SELECTION OF DEVICES WITH MAXIMUM RELIABILITY, AND 2) PROVIDE MOTIVATION FOR THE DEVELOPMENT OF LONG LIFE, RADIATION RESISTANT MICROELECTRONIC DEVICES. THE APPROACH IS TO WORK CLOSELY WITH OTHER ORGANIZATIONS INVESTIGATING AND USING MSI/LSI DEVICES. PARTICULAR EMPHASIS WILL BE PLACED ON DEVELOPING A CLOSE WORKING RELATIONSHIP WITH NASA ERC AUGMENTED BY THE NECESSARY JPL IN-HOUSE ACTIVITY TO IDENTIFY AND PURSUE THE NECESSARY RESEARCH TO ADAPT THE ERC RESULTS TO SPACECRAFT APPLICATIONS. IN ORDER TO CARRY OUT THIS TASK WITH THE MINIMUM TOTAL NASA RESOURCES, IT IS NECESSARY THAT ERC ACCEPT PERFORMANCE COMMITMENTS FOR CERTAIN RESEARCH AND DEVELOPMENT REQUIREMENTS.

RTOP NO. 125-25-13 TITLE: INSPECTION TECHNIQUES FOR ELECTRONIC PACKAGING JOINING METHODS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: FOSTER, J. V. TEL. 415-961-1111

TECHNICAL SUMMARY

A NONDESTRUCTIVE TEST METHOD IS BEING DEVELOPED FOR VERIFYING THE INTEGRITY OF JOINTS IN ELECTRONIC COMPONENTS AND MODULES DURING FABRICATION OF AERONAUTICAL AND SPACE EQUIPMENT. CURRENT INSPECTION METHODS RELY ON A VISUAL COMPARISON OF THE FINISHED JOINT WITH A PHOTOGRAPHIC ENLARGEMENT OF A SAMPLE JOINT. FAILURES DURING SUBSEQUENT TESTING AND USE HAVE SHOWN THAT VISUAL INSPECTION IS NOT ADEQUATE FOR ESTABLISHING THE ELECTRICAL OR MECHANICAL BOND INTEGRITY OF THE ELEMENTS. THEREFORE, THIS WORK IS DIRECTED TOWARD RECTIFYING THE PRESENT INADEQUACIES AND LIMITATIONS AND THUS REDUCE POTENTIAL SPACECRAFT FAILURES AS WELL AS THE COST OF FABRICATION. THE INITIAL WORK ON THIS PROGRAM INVOLVED THE STUDY AND EVALUATION OF THE MOST PROMISING TECHNIQUES AS INDICATORS OF WELD QUALITY. NEXT, INSTRUMENTATION BASED UPON A RECOMMENDED CONFIGURATION WAS SUCCESSFULLY DEVELOPED AND TESTED. ADDITIONAL EFFORT WILL BE DEVOTED TO TESTING ON PRODUCTION LINES, MODIFYING UNITS AS REQUIRED, ESTABLISHING AND IMPLEMENTING MECHANICS OF GETTING UNITS INTO GENERAL USE, AND DETERMINING APPLICABILITY TO OTHER SIMILAR JOINING METHODS.

RTOP NO. 125-25-13 TITLE: MANNED SPACE SHUTTLE: ANTENNA TECHNIQUES AND MATERIALS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: MOORE, W. M. TEL. 703-827-3429

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP THE CRITICAL TECHNOLOGY REQUIRED FOR DESIGNING ANTENNAS COMPATIBLE WITH THE STRUCTURE AND THERMAL

ENVIRONMENT OF THE SPACE SHUTTLE. ANALYTICAL AND EXPERIMENTAL ANTENNA WORK WILL BE CONDUCTED TO EVALUATE THE PERFORMANCE OF FLUSH MOUNTED ANTENNA ARRAYS COVERED WITH DIELECTRIC MATERIALS. STUDIES WILL BE CONDUCTED TO ASSESS THE POTENTIAL PROBLEM OF ANTENNA BREAKDOWN AND DAMAGE DURING EARTH ENTRY. DURING FY-70 AN IN-HOUSE AND CONTRACTUAL PROGRAM WILL BE INITIATED TO DETERMINE ANALYTICALLY AND EXPERIMENTALLY THE PERFORMANCE OF ANTENNAS COVERED WITH DIELECTRIC MATERIALS. CANDIDATE ANTENNA DESIGNS AND THERMAL MATERIALS WILL BE INVESTIGATED. DURING FY-71 THE ANTENNA ANALYTICAL AND MATERIALS TEST WORK WILL BE COMBINED TO DETERMINE ANTENNA DESIGN APPROACHES SUITABLE FOR SPACE SHUTTLE APPLICATIONS. DURING FY-72 SPECIFIC ANTENNA DESIGNS WILL BE DEVELOPED AND TESTED.

RTOP NO. 125-25-17 TITLE: DEVELOPMENT OF MICROCIRCUIT REQUIREMENTS  
FOR LONGTERM SPACE APPLICATIONS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MOORE, W. M. TEL. 205-453-1120

TECHNICAL SUMMARY

REQUIREMENTS WILL BE DEVELOPED FOR THE DESIGN, MANUFACTURING, AND QUALITY AND RELIABILITY ASSURANCE OF MICROELECTRONICS FOR SPACE APPLICATIONS. MICROCIRCUITS AND OTHER ELECTRONIC DEVICES ARE NEEDED FOR HIGH RELIABILITY APPLICATION IN SPACE STATIONS, SHUTTLES, AND SIMILAR SYSTEMS WITH AN EXPECTED LIFE OF AT LEAST 15 YEARS. TO ASSURE AVAILABILITY OF SUCH DEVICES, IT WILL BE NECESSARY TO: (1) INCREASE THE USAGE OF LARGE SCALE INTEGRATED (LSI) CIRCUITS; (2) OPTIMIZE PROCESS CONTROLS THROUGH THE DEVELOPMENT OF IMPROVED IN-PROCESS TEST METHODS AND STANDARDS; (3) DEVELOP MORE SENSITIVE SCREENING TECHNIQUES FOR COMPLETED DEVICES. THE SAME BASIC APPROACH DESCRIBED FOR IMPROVING LSI RELIABILITY WILL BE APPLIED TO OTHER DEVICES, PARTICULARLY POWER TRANSISTORS, SINCE IT IS ANTICIPATED THAT THE SPACE SYSTEMS UNDER CONSIDERATION WILL HAVE LARGE POWER REQUIREMENTS. EMPHASIS WILL BE PLACED ON SURFACE CONTROL OF THESE DEVICES DURING FABRICATION, USING SUCH TECHNIQUES AS AUGER ELECTRON SPECTROSCOPY AND ION BEAM SPECTROSCOPY. INDEPENDENT BULK EFFECT STUDIES ARE ALREADY UNDERWAY AND COMPLEMENT THIS PROPOSED WORK.

RTOP NO. 125-25-18 TITLE: SCREENING AND RELIABILITY TESTING FOR  
SPACE SHUTTLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MOORE, W. M. TEL. 205-453-1120

TECHNICAL SUMMARY

OBJECTIVES: THE WORK FOR THE SPACE SHUTTLE WILL BE AIMED DIRECTLY AT PROVIDING A BODY OF DESIGNER'S TECHNICAL DATA AND TEST METHODS OF PROVEN VALIDITY BY THE TIME DESIGN DECISIONS FOR THE MAKEUP OF THE INTEGRATED ELECTRONICS SYSTEM MUST FINALLY BE MADE. WORK ALREADY UNDERWAY ON SCREENING, WORKMANSHIP STANDARDS AND RELIABILITY TESTING, UNDER RTOP'S 125-25-08 AND 09, WILL ALSO BE USED TO THE FULL. APPROACH: LSI DESIGN WILL BE COVERED BY DESIGN STANDARDS FOR DEVICE SELECTION AND LAYOUT. LSI QUALIFICATION WILL BE DEFINED FOR SPACE SHUTTLE SPECIFICATIONS. LSI SCREENING METHODS FOR



THE SELECTED FAMILIES OF PARTS WILL BE DEFINED AND DOCUMENTED. RELIABILITY TESTING WILL SEEK TO CORRELATE ACCELERATED AND SCREENING TESTS WITH REAL TIME LIFE TESTS.

RTOP NO. 125-25-19 TITLE: MATERIALS FOR ANTENNA PROTECTIVE COATINGS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: NELSON, C. H. TEL. 703-827-3285  
TECHNICAL SUMMARY

RESEARCH IS PERFORMED TO DEVELOP DURABLE DIELECTRIC MATERIALS FOR PROTECTION AND INSULATION OF ANTENNA SURFACES ABOARD REUSABLE SPACE-SHUTTLE VEHICLES. INVESTIGATIONS ARE CONCENTRATED ON MATERIALS EXHIBITING MECHANICAL INTEGRITY, HIGH DIELECTRIC STRENGTH, AND LOW DIELECTRIC LOSSES AT HIGH TEMPERATURES AND AT MICROWAVE FREQUENCIES, AND WHICH ARE AMENABLE TO PREPARATION IN THE REQUIRED CONFIGURATIONS.

ACTIVITIES INCLUDE SELECTION OF MATERIALS ON THE BASIS OF PREDICTED OR DEMONSTRATED DESIRABLE DIELECTRIC PROPERTIES, DEVELOPMENT OF PREPARATIVE METHODS, AND CORRELATION OF DIELECTRIC, THERMAL, AND MECHANICAL PROPERTIES WITH COMPOSITION AND PREPARATIVE CONDITIONS. RESULTANT MATERIALS ARE EVALUATED FOR COMPATIBILITY WITH STATED REQUIREMENTS OF SPACE-SHUTTLE ANTENNAS. THE MOST PROMISING COMBINATIONS OF DIELECTRIC, THERMAL, AND STRUCTURAL PROPERTIES WITH PRACTICABILITY OF PREPARATIVE TECHNIQUES ARE REFINED TO YIELD THE DESIRED MATERIALS TECHNOLOGY.

RTOP NO. 126-13-10 TITLE: GENERAL AERODYNAMICS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THIS RESEARCH DEALS WITH THEORETICAL AND EXPERIMENTAL AERODYNAMIC INVESTIGATIONS OF COMPONENTS, COMBINATIONS, AND COMPLETE RESEARCH CONFIGURATIONS FOR AERONAUTICAL VEHICLES THROUGHOUT THE FLIGHT SPEED RANGE. IT INCLUDES CONTINUING STUDIES OF FLOW FIELDS AND BOUNDARY-LAYER PHENOMENA, VORTEX AND INTERFERENCE FLOWS, COMPUTER PREDICTION METHODS AND CORRELATION WITH EXPERIMENT, AERODYNAMICS OF FLEXIBLE WINGS AND DEPLOYABLE PARAWINGS FOR AERONAUTICAL APPLICATIONS, EXTERNAL STORE EFFECTS AND SEPARATION CHARACTERISTICS, EXPERIMENTALLY-DETERMINED DYNAMIC DERIVATIVES. ALSO RESEARCH ON SUPERCRITICAL AIRFOILS AND WINGS, REDUCTION OF FUSELAGE LOSSES, FAVORABLE WING-PYLON-NACELLE INTERFERENCES, AND TIP VORTEX SUPPRESSION FOR IMPROVING AERODYNAMIC CHARACTERISTICS AT HIGH SUBSONIC AND SONIC SPEEDS. THIS RESEARCH IS BEING ACCOMPLISHED BY THE DEVELOPMENT OF NEW THEORETICAL APPROACHES, THE APPLICATION OF EXISTING THEORIES AND BY SYSTEMATIC WIND-TUNNEL AND FLIGHT TESTING. THE PURPOSE IS TO PROVIDE ADVANCED RESEARCH INFORMATION AND TECHNIQUES FOR PREDICTING AND IMPROVING THE AERODYNAMICS OF AERONAUTICAL VEHICLES.



**RTOP NO. 126-13-10 TITLE: GENERAL AERODYNAMIC RESEARCH TO PROVIDE  
AND IMPROVE PREDICTION TECHNIQUES AND TO  
EVOLVE AND TEST PROMISING CONCEPTS**

**ORGANIZATION: AMES RESEARCH CENTER**

**MONITOR: ROBINSON, R. G. TEL. 415-961-1111**

**TECHNICAL SUMMARY**

ANALYTICAL AND EXPERIMENTAL STUDIES ARE IN PROGRESS IN THE AREA OF GENERAL AERODYNAMIC RESEARCH TO (1) EVALUATE AND IMPROVE AVAILABLE METHODS FOR THE PREDICTION OF THE AERODYNAMIC BEHAVIOR OF AIRCRAFT COMPONENTS (INDIVIDUALLY AND COLLECTIVELY), (2) EVOLVE NEW METHODS WHEN THE NEED IS INDICATED, AND (3) PHYSICALLY TEST (IN WIND TUNNELS AND SIMILAR EQUIPMENT) NEW CONCEPTS, INNOVATIONS, AND AERODYNAMIC CONFIGURATIONS OR SUGGESTIONS CONSIDERED PROMISING WITH RESPECT TO IMPROVED AERODYNAMIC PERFORMANCE. THE RESULTS OF THE RESEARCH SHOULD PLACE IN THE HANDS OF THOSE CONCERNED WITH THE DESIGN AND PERFORMANCE PREDICTION OF AIRCRAFT MORE ACCURATE, FLEXIBLE, AND COMPREHENSIVE ANALYTICAL PROCEDURES (INCLUDING ELECTRONIC COMPUTING TECHNIQUES), SHOULD PROVIDE A BETTER UNDERSTANDING OF THE AERODYNAMIC PROCESSES INVOLVED, AND INDICATE THE AIRCRAFT MODIFICATIONS MOST APT TO PRODUCE IMPROVED PERFORMANCE.

**RTOP NO. 126-13-10 TITLE: GENERAL AERODYNAMICS**

**ORGANIZATION: FLIGHT RESEARCH CENTER**

**MONITOR: SALTZMAN, E. J. TEL. 805-258-3311**

**TECHNICAL SUMMARY**

VARIOUS FLIGHT VEHICLES WILL BE USED TO INVESTIGATE LOCAL AERODYNAMICS THAT ARE ESSENTIALLY INDEPENDENT OF THE AIRCRAFT CONFIGURATION BUT ARE DEPENDENT ON ENVIRONMENTS AND REYNOLDS NUMBERS THAT CANNOT BE ADEQUATELY REPRODUCED IN GROUND FACILITIES. AREAS OF INVESTIGATION WILL INCLUDE SKIN FRICTION, BASE DRAG, ROUGHNESS EFFECTS, AND AN ASSESSMENT OF BOUNDARY-LAYER PARAMETERS AS AFFECTED BY PRESSURE GRADIENT. WHERE HIGH REYNOLDS NUMBERS ARE REQUIRED, THE WORK WILL BE DONE ON LARGE AIRCRAFT SUCH AS THE C5A OR ON HIGH-SPEED AIRCRAFT SUCH AS THE YF-12. WHERE THIS CONDITION IS NOT CRITICAL THE WORK MAY BE DONE ON A SPECIAL FIN ATTACHED TO AN F-104 OR BY MEANS OF A FREE FALL DROP BODY IF IT IS DESIRABLE TO ELIMINATE THE EFFECT OF ADJACENT BODIES.

**RTOP NO. 126-13-11 TITLE: SONIC BOOM GENERATION AND PROPAGATION**

**ORGANIZATION: LANGLEY RESEARCH CENTER**

**MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285**

**TECHNICAL SUMMARY**

THE OBJECTIVE OF THIS WORK IS TO DEVELOP AN IMPROVED UNDERSTANDING OF SONIC BOOM PHENOMENA, TO PROVIDE MORE ACCURATE AND MORE CONVENIENT PREDICTION TECHNIQUES, AND TO DEVELOP DESIGN METHODS THAT WILL LEAD TO ADVANCED LOW-BOOM SST AND HST CONFIGURATIONS WHICH RETAIN ATTRACTIVE ECONOMIC FEATURES. ALTHOUGH THE PRIMARY EMPHASIS CONTINUES TO BE DIRECTED TO STEADY LEVEL FLIGHT, INCREASING ATTENTION WILL BE DEVOTED TO A STUDY OF ATMOSPHERIC AND TOPOGRAPHICAL FOCUSING, THE EFFECTS OF ATMOSPHERIC TURBULENCE, AND THE INFLUENCE OF AIRCRAFT

ACCELERATION AND MANEUVERS. THE RESEARCH WILL BE ACCOMPLISHED BY WIND-TUNNEL AND LABORATORY EXPERIMENTATION, BY THE CONDUCT OF THEORETICAL STUDIES, AND BY THE ACQUISITION AND ANALYSIS OF DATA FROM FLIGHT TEST PROGRAMS.

RTOP NO. 126-13-11 TITLE: SONIC BOOM GENERATION AND PROPAGATION

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

TECHNICAL SUMMARY

ANALYTICAL AND EXPERIMENTAL STUDIES ARE IN PROGRESS TO PREDICT NEAR- AND FAR-FIELD PRESSURES FOR ARBITRARY AIRCRAFT CONFIGURATIONS AND TO OPTIMIZE AIRCRAFT CONFIGURATIONS FOR MINIMUM SONIC BOOM AND MAXIMUM PERFORMANCE. EXISTING THEORETICAL METHODS ARE BEING PROGRAMMED FOR COMPUTERS, AND THE COMPUTED RESULTS FOR VARIOUS PROPOSED "LOW-BOOM" CONFIGURATIONS ARE BEING COMPARED WITH EXPERIMENTAL RESULTS OBTAINED FOR MODELS TESTED IN THE AMES UNITARY PLAN WIND TUNNEL. RESULTS FROM THIS RESEARCH WILL ULTIMATELY BE USED IN THE DESIGN OF SUPERSONIC AIRCRAFT WHICH CAUSE ONLY MINIMUM SONIC BOOM INTENSITIES.

RTOP NO. 126-14-10 TITLE: (U) GUST LOADS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE WORK TO BE PERFORMED UNDER THIS RTOP IS TO PROVIDE THE TECHNOLOGY DEVELOPMENT NECESSARY FOR IMPROVED ABILITY TO HANDLE GUST LOADS AND RESPONSE IN THE DESIGN OF NEW AIRCRAFT. THIS WORK WILL PROVIDE A BETTER UNDERSTANDING OF THE EFFECTS OF COMBINED VERTICAL AND LATERAL INPUTS FOR A MORE RATIONAL PREDICTION OF GUST LOADS IN THE REAL ENVIRONMENT. RESPONSE CALCULATION METHODS WILL BE VALIDATED BY CORRELATION WITH EXISTING FLIGHT DATA AND WITH EXPERIMENTAL RESULTS TO BE OBTAINED IN USING AN AIRSTREAM OSCILLATOR. EXPERIMENTAL AND ANALYTICAL STUDIES OF METHODS OF ALLEVIATING RESPONSE THROUGH MODAL SUPPRESSION SYSTEMS AND THROUGH SEAT ISOLATION SYSTEMS WILL BE MADE.

RTOP NO. 126-14-11 TITLE: AERODYNAMIC LOADS INCLUDING ACOUSTIC RESPONSE AND PANEL FLUTTER

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

TECHNICAL SUMMARY

FOR AN AIRCRAFT DESIGNER TO DESIGN RELIABLE STRUCTURES OF MINIMUM WEIGHT HE MUST BE ABLE TO PREDICT ACCURATELY THE AERODYNAMIC LOADS OVER THE AIRCRAFT FOR THE EXPECTED FLIGHT CONDITIONS. THERE IS CONSIDERABLE NEED FOR RESEARCH IN THE PREDICTION OF LOADS, ACOUSTIC RESPONSE AND PANEL FLUTTER OF STRUCTURES AT SPEEDS RANGING FROM TRANSONIC TO HYPERSONIC AND AT REYNOLDS NUMBERS APPROACHING FLIGHT CONDITIONS. EXPERIMENTAL STUDIES OF MODELS IN WIND TUNNELS ARE IN

PROGRESS TO AID IN THE DEVELOPMENT OF METHODS FOR PREDICTING THESE EFFECTS FOR HIGH PERFORMANCE AIRCRAFT.

RTOP NO. 126-14-12 TITLE: (U) BUFFETING  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

ADVANCED FIGHTER AIRCRAFT MUST HAVE IMPROVED MANEUVERABILITY. IN SOME CASES, MANEUVERABILITY CAN BE LIMITED BY THE OCCURRENCE OF BUFFETING. THIS RESEARCH IS INTENDED TO PROVIDE INFORMATION ON THOSE CONFIGURATION CHARACTERISTICS WHICH WOULD IMPROVE BUFFET BOUNDARIES AND TO DEVELOP TECHNIQUES FOR PREDICTING BUFFETING INTENSITY BEYOND THE BOUNDARY. RESULTS OF THIS WORK SHOULD BE DIRECTLY APPLICABLE IN THE DEVELOPMENT OF THE F-14 AND F-15 FIGHTER AIRCRAFT. SINCE BUFFETING IS ASSOCIATED WITH SEPARATED FLOW, THE WORK WILL BE PRIMARILY EXPERIMENTAL IN NATURE. WIND-TUNNEL TECHNIQUES FOR PREDICTING BUFFET BOUNDARY AND BUFFET INTENSITY WILL BE VALIDATED BY COMPARISON WITH FLIGHT RESULTS.

RTOP NO. 126-14-12 TITLE: RESEARCH ON THE CAUSES, INTENSITY, AND PERTINENT CHARACTERISTICS OF AERODYNAMIC BUFFETING

ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

THE PERFORMANCE, MANEUVERABILITY, AND SOMETIMES THE SAFETY OF AIR VEHICLES IS FREQUENTLY LIMITED OR JEOPARDIZED BY THE APPEARANCE, UNDER CERTAIN FLIGHT CONDITIONS, OF THE LARGE, UNSTEADY AERODYNAMIC FORCES KNOWN AS BUFFET. SOME OF THE PROBLEMS RESULTING FROM BUFFET ARE PILOT ANNOYANCE, REDUCED PRECISION OF AIRCRAFT CONTROL, INABILITY TO ACCOMPLISH SOME MANEUVERS THAT ARE POSSIBLE UNDER NON-BUFFET CONDITIONS, AND POSSIBLE STRUCTURAL FAILURE. A RELATIVELY LARGE WIND TUNNEL MODEL, CORRESPONDING TO AN AIRCRAFT FOR WHICH CONSIDERABLE FLIGHT DATA IN BUFFET CONDITIONS EXIST, IS BEING FABRICATED. MEASUREMENTS WILL BE TAKEN OF ALL FACTORS REASONABLY EXPECTED TO CAUSE OR INFLUENCE BUFFET, AND OF THE ACTUAL AERODYNAMIC MECHANISM OF THE BUFFET PROCESS. AN EFFORT WILL BE MADE TO DESCRIBE THE PROCESS ANALYTICALLY IN ORDER TO PROVIDE A MORE FUNDAMENTAL UNDERSTANDING AND ALLOW FOR BUFFET PREDICTION.

RTOP NO. 126-14-13 TITLE: (U) ACOUSTIC RESPONSE  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THIS WORK INCLUDES THE RESPONSE OF FLIGHT STRUCTURES TO ACOUSTIC LOADS, SUCH AS THOSE FROM THE AERO BOUNDARY LAYER AND THE POWER PLANTS. INCLUDED ARE SUCH SPECIFIC TOPICS AS SONIC FATIGUE, NOISE TRANSMISSION, VIBRATION RESPONSES OF COMPLEX STRUCTURES SUCH AS

PAYLOADS, AND THE DEFINITION OF BOUNDARY LAYER LOADS ON AERO SURFACES. BOTH ANALYTICAL AND EXPERIMENTAL STUDIES ARE INVOLVED. WIND-TUNNEL, FREE-FLIGHT, AND GROUND SIMULATION TESTS OVER A TEMPERATURE RANGE ARE ANTICIPATED. THE OBJECTIVES OF THE WORK ARE TO BE ABLE TO PREDICT THE RESPONSES OF VARIOUS TYPES OF STRUCTURES TO ACOUSTIC LOADS, AND TO BE ABLE TO DESIGN LIGHTER WEIGHT NOISE RESISTANT STRUCTURES.

RTOP NO. 126-14-14 TITLE: (U) FLUTTER AND AEROELASTICITY  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE RESEARCH EFFORT TO BE CONDUCTED UNDER THIS RTOP IS INTENDED TO PROVIDE THE TECHNOLOGY FOR THE ACCURATE PREDICTION OF FLUTTER AND OTHER AEROELASTIC PHENOMENA. THE METHODS WILL BE BOTH EXPERIMENTAL AND ANALYTICAL IN NATURE AND EMPHASIS WILL BE PLACED ON MAKING THE METHODS SUITABLE FOR USE DURING AIRCRAFT DESIGN. IMPROVEMENTS IN THE ACCURACY OF THESE PREDICTION AND DESIGN METHODS WILL PROVIDE FOR SAFER, MORE EFFICIENT AIRCRAFT DESIGNS. THE WORK WILL INCLUDE THE FOLLOWING: 1. IMPROVED REPRESENTATIONS OF UNSTEADY AERODYNAMICS, INCLUDING VALIDATION OF THESE METHODS BY COMPARISON WITH WIND-TUNNEL EXPERIMENTS. 2. FURTHER DEVELOPMENT OF THE THEORY AND PRACTICAL METHOD OF OPTIMIZING DESIGNS FOR AEROELASTIC RESTRAINTS. 3. DEVELOPMENT OF EXPERIMENTAL AND ANALYTICAL CAPABILITY FOR STUDYING FLUTTER SUPPRESSION SYSTEMS USING ACTIVE CONTROLS. 4. IMPROVED TECHNIQUES FOR DESIGNING PANELS TO BE FREE OF FLUTTER. 5. EXPLORATORY STUDIES OF AEROELASTIC PROBLEMS ASSOCIATED WITH HYPERSONIC FLIGHT. THE WORK WILL INCLUDE BOTH IN-HOUSE, UNIVERSITY GRANT, AND CONTRACTUAL EFFORTS.

RTOP NO. 126-14-15 TITLE: FATIGUE  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO INCREASE THE RELIABILITY AND SAFETY OF CONTEMPORARY AND FUTURE AIRCRAFT BY DEVELOPING THE UNDERSTANDING OF THE FATIGUE PHENOMENA AND BY GENERATING ENGINEERING RULES USEFUL IN AIRCRAFT DESIGN AND FATIGUE ANALYSES. FATIGUE DAMAGE JEOPORDIZES THE INTEGRITY OF AIRCRAFT IN A LARGELY UNPREDICTABLE MANNER, THUS IMPERILIZING PASSENGERS OR MILITARY MISSIONS. FACTORS AFFECTING FATIGUE PERFORMANCE ARE NUMEROUS AND INCLUDE THE MAGNITUDE, SEQUENCE, AND STATISTICAL CONTENT OF LOADS, GEOMETRY OF A PART, CORROSION, TYPE OF AIRCRAFT MISSION, AND MATERIAL OF CONSTRUCTION. FUTURE HIGH SPEED AIRCRAFT WILL ADDITIONALLY BE SUBJECTED TO ELEVATED TEMPERATURES AND WILL UTILIZE MANY NEW MATERIALS INCLUDING SUPERALLOYS AND COMPOSITES. THE EFFECTS OF SUCH FACTORS ON FATIGUE BEHAVIOR WILL BE INVESTIGATED IN THE FOLLOWING AREAS: 1. FUNDAMENTAL MECHANISMS OF FATIGUE 2. CRACK PROPAGATION AND RESIDUAL STRENGTH 3. FATIGUE OF COMPOSITE MATERIALS 4. DESIGN PROCEDURES FOR LONG FATIGUE LIFE 5. STRUCTURAL FATIGUE UNDER STOCHASTIC LOADING.

THE RESULT OF THIS RESEARCH WILL HELP DESIGNERS IMPROVE THE RESISTANCE OF STRUCTURES TO FATIGUE AND IMPROVE ANALYSIS OF FATIGUE PROBLEMS; THE RESULTS WILL HELP OPERATORS MAINTAIN SAFETY AND PROLONG THE USEFUL LIFE OF AIRCRAFT. TO ACCOMPLISH THE OBJECTIVE, FATIGUE ANALYSIS METHODS WILL BE DEVELOPED; EXPERIMENTS WILL BE CONDUCTED TO VERIFY ANALYSES.

RTOP NO. 126-14-16 TITLE: STRUCTURAL MECHANICS AND COMPUTER METHODS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

IDENTIFY NEEDED IMPROVEMENTS IN AIRCRAFT STRUCTURAL DESIGN METHODOLOGY AND DEFICIENCIES IN AIRCRAFT STRUCTURES AND MATERIALS TECHNOLOGY THROUGH STRUCTURAL DESIGN STUDIES OF ADVANCED AIRCRAFT. IMPROVE THE AIRCRAFT DESIGN PROCESS THROUGH DEVELOPMENT OF COMPUTER METHODS AND PROGRAMS FOR ACCURATE ANALYSIS AND RAPID, OPTIMUM DESIGN OF STRUCTURAL COMPONENTS. IMPROVE THE TECHNOLOGY BASE FOR DESIGN OF SAFE, RELIABLE AIRCRAFT STRUCTURES THROUGH ANALYTICAL AND EXPERIMENTAL RESEARCH TOWARD ACCURATE PREDICTION OF FRACTURE OF AIRCRAFT STRUCTURES CONTAINING NOTCHES AND CRACKS.

RTOP NO. 126-14-17 TITLE: COMPOSITES  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THIS RESEARCH EFFORT IS PROPOSED TO DEVELOP THE TECHNOLOGY THAT WILL PERMIT EARLY UTILIZATION AND EXPLOITATION OF ADVANCED FILAMENTARY COMPOSITES IN AIRCRAFT STRUCTURES THEREBY ACHIEVING SIGNIFICANT IMPROVEMENT IN THE STRUCTURAL PERFORMANCE. THE WORK CONSISTS OF THE FOLLOWING: 1. DEVELOPMENT OF CONCEPTS AND FABRICATION TECHNOLOGY FOR REINFORCEMENT OF METAL STRUCTURES WITH ADVANCED FILAMENTARY COMPOSITES 2. INITIATION OF STUDIES TO DETERMINE THE FEASIBILITY AND TO PREPARE PLANS FOR UTILIZING ADVANCED FILAMENTARY COMPOSITES IN COMMERCIAL OR MILITARY AIRCRAFT STRUCTURES 3. STUDY OF MECHANICS OF FIBER REINFORCED COMPOSITES. BOTH IN-HOUSE AND CONTRACTUAL EFFORTS WILL BE MADE. THE RESULTS OF THESE EFFORTS WILL PROVIDE NEW TECHNICAL INFORMATION AND WILL DEVELOP CONFIDENCE REQUIRED TO MAKE EARLY APPLICATION OF FILAMENTARY COMPOSITES IN BOTH SUBSONIC AND SUPERSONIC AIRCRAFT STRUCTURES.

RTOP NO. 126-14-17 TITLE: COMPOSITES  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 205-453-1115

TECHNICAL SUMMARY

FILAMENTARY COMPOSITE STRUCTURES EMPLOYING ADVANCED, HIGH MODULUS MATERIALS (BORON, GRAPHITE, TUNGSTEN, ETC.), IN METAL AND NON-METAL MATRICES, ARE RAPIDLY COMING INTO USE ON HYPERSONIC AIRCRAFT; HOWEVER, THE PRESENT AVAILABLE STRUCTURAL MATERIALS

UTILIZED FOR AIRCRAFT CONSTRUCTION IS MARGINAL IN ACHIEVING THE NECESSARY STRENGTH TO WEIGHT. MSFC IS DEVELOPING FABRICATION METHODS AND PROCESSES FOR UTILIZING HIGH STRENGTH FIBERS FOR VARIOUS APPLICATIONS IN HIGH STRENGTH TO WEIGHT COMPOSITE STRUCTURES. PRELIMINARY PROGRAMS HAVE ALREADY BEEN ESTABLISHED IN BORON AND GRAPHITE FIBER UTILIZING VARIOUS MATRICES AND COMBINATIONS TO ACHIEVE THE DESIRED STRENGTH TO WEIGHT RATIO. THIS PROPOSED EFFORT WILL PROVIDE THE NECESSARY TECHNOLOGY TO DEVELOP FABRICATION AND INSPECTION TECHNIQUES FOR METALLIC STRUCTURES REINFORCED WITH FILAMENTARY COMPOSITES WHICH COULD BE UTILIZED IN SPECIFIC AREAS OF PRESENT AND FUTURE AIRCRAFT AND SPACE VEHICLES. ALSO, THIS PROGRAM WILL PROVIDE AN INTEGRATED EFFORT LEADING TOWARD THE SUCCESSFUL DEVELOPMENT OF SELECTED NDT METHODS, TECHNIQUES, AND STANDARDS TO BE APPLIED IN THE EVALUATION OF ADVANCED FILAMENTARY COMPOSITES.

RTOP NO. 126-14-18 TITLE: FLIGHT LOADS MEASUREMENT TECHNIQUES

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: JENKINS, J. M. TEL. 805-258-3311

TECHNICAL SUMMARY

PROBLEMS HAVE OCCURRED WHEN FLIGHT-LOADS MEASUREMENTS HAVE BEEN REQUIRED ON AIRCRAFT WHICH ARE SUBJECT TO SIGNIFICANT AERODYNAMIC HEATING. THE AERODYNAMIC HEATING OF FLIGHT STRUCTURES INDUCES NONUNIFORM TEMPERATURE FIELDS THROUGHOUT THE STRUCTURE. THE NONUNIFORM TEMPERATURE FIELDS LEAD TO LARGE INDUCED THERMAL STRESSES WHICH ARE SENSED BY THE STRAIN GAGES. IF THE OBJECTIVE IS TO MEASURE AERODYNAMIC LOADS ONLY, THEN THE UNWANTED TEMPERATURES INDUCED STRAIN-GAGE OUTPUTS MUST BE ACCOUNTED FOR AND DEDUCTED FROM FLIGHT DATA. THIS OPERATION IS TO BE CONDUCTED BY GROUND-TEMPERATURE SIMULATION OF THE AERODYNAMIC HEATING, MEASURING THE THERMAL RESPONSES OF THE STRAIN GAGES AND THEN UTILIZING THIS INFORMATION AS A THERMAL CALIBRATION FOR CORRECTED PURPOSES.

RTOP NO. 126-15-10 TITLE: BEARINGS, SEALS, HYDRAULICS, LUBRICATION

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: JOHNSON, R. L. TEL.

TECHNICAL SUMMARY

BASIC MATERIALS, DEVELOPMENT, DESIGN THEORY, ANALYSIS AND EXPERIMENTATION WILL BE PERFORMED FOR EXTREME CONDITIONS WITH LUBRICANTS, LUBRICATION SYSTEMS, COMPONENT MATERIALS AND COMPONENT DESIGNS FOR BEARINGS, SEALS, GEARS OF ADVANCED AIRCRAFT TURBINE ENGINES AND HYDRAULIC SYSTEMS TO ACHIEVE EFFICIENT PERFORMANCE, RELIABILITY AND EXTENDED LIFE.

RTOP NO. 126-15-11 TITLE: ATMOSPHERIC NUCLEAR PROPULSION

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: ROM, F. E. TEL.

TECHNICAL SUMMARY

ANALYTICAL AND LIMITED EXPERIMENTAL INVESTIGATIONS WILL BE



CARRIED OUT TO ASSESS THE FEASIBILITY OF SAFE, PRACTICAL LARGE SUBSONIC NUCLEAR AIRCRAFT. THE EMPHASIS ON THE STUDY IS PLACED ON (1) SAFETY, (2) LONG LIFE POWERPLANT COMPONENTS, AND (3) INTEGRATED POWERPLANT DESIGNS. 1. THE SAFETY RESEARCH IS DIRECTED TOWARD DEVELOPING METHODS FOR PREVENTING THE RELEASE OF FISSION PRODUCTS DURING AND AFTER MAJOR ACCIDENTS BY CONTAINING THE REACTOR WITHIN A CONTAINMENT VESSEL DURING AND AFTER A HIGH VELOCITY IMPACT. 2. RESEARCH WILL BE DIRECTED TOWARD A REACTOR FUEL THAT CAN ACHIEVE BURNUP OF OVER 10 PERCENT AT OPERATING CONDITIONS. 3. THE WORK ON INTEGRATED POWERPLANTS IS DIRECTED TOWARD PROVIDING REALISTIC WEIGHT AND PERFORMANCE FOR THE COMPLETE SYSTEMS.

RTOP NO. 126-15-13 TITLE: ADVANCED PROPULSION SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVES ARE TO DEFINE ADVANCED AIR-BREATHING PROPULSION CONCEPTS FOR FUTURE MILITARY AND COMMERCIAL AIRCRAFT, AND TO CONDUCT EXPERIMENTAL RESEARCH WHICH WILL ESTABLISH CONCEPT FEASIBILITY OR IMPROVE THE PERFORMANCE OF EXISTING SYSTEMS.

RTOP NO. 126-15-13 TITLE: ADVANCED PROPULSION SYSTEMS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: LOGAN, W. O., JR. TEL. 000-433-4000

TECHNICAL SUMMARY

PROJECTED AERONAUTICAL MISSIONS FOR THE 1970'S AND 1980'S COVER A SPECTRUM OF FLIGHT REGIMES FROM HOVERCRAFT TO HYPERSONIC FLIGHT AND FROM SINGLE-PLACE LIGHTPLANES TO MILLION-POUND TRANSPORTS. TO PROVIDE EFFICIENT, RELIABLE, ECONOMICALLY FEASIBLE PROPULSION SYSTEMS FOR THESE MISSIONS, NEW CONCEPTS AND PROPULSION CYCLES WILL BE FORMULATED AND EXPLORED. RESULTS OF THESE STUDIES WILL PROVIDE FUNDAMENTAL SCIENTIFIC AND ENGINEERING DATA ON WHICH TO STRUCTURE FULL-SCALE PROPULSION RESEARCH PROGRAMS.

RTOP NO. 126-15-14 TITLE: PERFORMANCE OF HIGH PERFORMANCE AIRCRAFT  
PROPULSION SYSTEMS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: BELLMAN, D. R. TEL. 805-258-3311

TECHNICAL SUMMARY

INTERACTIONS BETWEEN A JET ENGINE AND AN AIRFRAME CAN HAVE SIGNIFICANT EFFECTS ON THE AIRCRAFT AND ENGINE PERFORMANCE PARTICULARLY FOR SUPERSONIC AIRCRAFT. STUDIES OF SUCH EFFECTS MUST BE DONE IN FULL SCALE FLIGHT BECAUSE UNCERTAIN SCALING FACTORS AND A LACK OF SUITABLY SIZED SUPERSONIC GROUND FACILITIES. FLIGHT TESTS ARE PLANNED FOR BOTH THE F-111A AND THE YF-12 AIRPLANES. ON THE F-111A AIRPLANE FLIGHT STUDIES ARE BEING MADE OF BOTH THE AFTERBODY AND THE FOREBODY FLOW FIELDS AND THEIR AFFECT ON THE PROPULSION SYSTEM, A COMPARABLE AFT-NACELLE FLOW-FIELD PROGRAM MAY BE DONE IN

**THE YF-12 AIRPLANE.**

**RTOP NO. 126-15-15 TITLE: SMALL GAS TURBINE ENGINES**  
**ORGANIZATION: LEWIS RESEARCH CENTER**  
**MONITOR: GOLD, H. TEL. 000-433-4000**

**TECHNICAL SUMMARY**

A PRACTICAL PRIVATE AIRPLANE FOR USE AS A MASS TRANSPORTATION MEDIUM MUST BE SAFE, RELIABLE, SIMPLE TO OPERATE, AND ECONOMICALLY WITHIN REACH OF A LARGE SEGMENT OF THE POPULATION. TECHNOLOGY FOR THE DEVELOPMENT AND TEST OF LOW-COST GAS TURBINE ENGINES TO POWER SMALL PRIVATE AIRPLANES WILL PARALLEL RESEARCH AT OTHER CENTERS ON IMPROVED FLIGHT CHARACTERISTICS, AVIONICS, AIR TRAFFIC CONTROL, AND OTHER FACETS OF TECHNOLOGY FOR GENERAL AVIATION DEVELOPMENT.

**RTOP NO. 126-15-16 TITLE: AERONAUTICAL ENGINE MATERIALS RESEARCH**  
**ORGANIZATION: LEWIS RESEARCH CENTER**  
**MONITOR: AULT, M. G. TEL. 216-433-4000**

**TECHNICAL SUMMARY**

THIS PROGRAM INVOLVES RESEARCH ON A WIDE VARIETY OF MATERIALS BEING CONSIDERED FOR USE IN FUTURE AIRCRAFT ENGINES. THE GENERAL OBJECTIVES OF THIS RESEARCH ARE: 1. TO IMPROVE THE PROPERTIES OF EXISTING MATERIALS USED FOR AERONAUTIC ENGINE APPLICATIONS TO PERMIT THEIR USE AT HIGHER TEMPERATURES FOR LONGER TIMES, IN LIGHTER WEIGHT CONFIGURATIONS, AND WITH GREATER RELIABILITY. 2. TO INVESTIGATE AND DEVELOP NEW MATERIALS, PROCESSING METHODS, AND ANALYTICAL PERFORMANCE PREDICTION METHODS THAT ARE SUPERIOR TO EXISTING ONES. MOST OF THIS PROGRAM WILL BE DONE UNDER CONTRACTS WITH VARIOUS INDUSTRIAL AND ACADEMIC RESEARCH LABORATORIES. BUT THE FINAL EVALUATION OF MATERIALS UNDER AIRCRAFT ENGINE TEST CONDITIONS WILL BE DONE IN-HOUSE. IN ADDITION, THIS PROGRAM CLOSELY COUPLES WITH OTHER IN-HOUSE WORK CONDUCTED UNDER RTOP 129-03-20.

**RTOP NO. 126-15-16 TITLE: OVERALL PERFORMANCE OF HIGH-SPEED AIRCRAFT**  
**ORGANIZATION: FLIGHT RESEARCH CENTER**  
**MONITOR: WASHINGTON, H. P. TEL. 805-258-3311**

**TECHNICAL SUMMARY**

THE FLIGHT TESTING OF HIGH-SPEED AIRCRAFT AT FRC TO DETERMINE ITS PERFORMANCE CHARACTERISTICS REQUIRES NEW TECHNIQUES AND METHODS TO OBTAIN MEANINGFUL RESULTS. THE OBJECTIVES OF THIS WORK PROGRAM IS TO DETERMINE THE PERFORMANCE CHARACTERISTICS OF THESE AIRCRAFT USING THE VARIOUS NEW TECHNIQUES AND TO COMPARE THESE RESULTS WITH WIND-TUNNEL AND/OR THEORETICAL PREDICTIONS IN A CONTINUING EFFORT TO RECOGNIZE WHEN NEW PREDICTION METHODS ARE NEEDED TO AID IN PRELIMINARY ESTIMATES.

RTOP NO. 126-61-10 TITLE: ATMOSPHERIC PARAMETERS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: WASHINGTON, H. P. TEL. 205-453-1120  
TECHNICAL SUMMARY

THIS RESEARCH IS TO UTILIZE THE FPS-16 RADAR/JIMSPHERE BALLOON SYSTEM TO ACHIEVE A BETTER UNDERSTANDING OF ATMOSPHERIC TURBULENCE FOR THE DEFINITION OF ATMOSPHERIC PARAMETERS FOR USE IN AIRCRAFT DESIGN AND OPERATION. THE RESULTS OF THIS RESEARCH SHOULD BETTER ESTABLISH THE RELATIONSHIP BETWEEN CAUSE AND EFFECT WITH REGARD TO IMPROVING CURRENT CAT FORECASTING PROCEDURES AND ALSO AIDING IN THE DEVELOPMENT OF AIRCRAFT DESIGN CRITERIA AND REMOTE CAT SENSING SYSTEMS.

RTOP NO. 126-61-10 TITLE: ATMOSPHERIC PARAMETERS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

OBJECTIVE IS TO DEFINE ATMOSPHERIC PARAMETERS FOR USE IN AIRCRAFT DESIGN AND OPERATION. PARAMETERS SUCH AS WINDS, SHEARS, AND TURBULENCE EXISTING IN THE ATMOSPHERE FROM THE SURFACE TO CRUISE ALTITUDES OF CURRENT AND FUTURE AIRCRAFT ARE OF PARTICULAR CONCERN TO STRUCTURAL LOADING AND STABILITY AND CONTROL PROBLEMS. TEMPERATURES AND DENSITIES BECOME OF IMPORTANCE TO CRUISE-RANGE PERFORMANCE EVALUATIONS. SEVERE STORMS REPRESENT THE MOST SEVERE GUST LOADING SOURCE FOR AIRCRAFT IN FLIGHT AND RESULT IN FLIGHT PATH DEVIATIONS, LANDING AND TAKEOFF HOLDS, AND OTHER SCHEDULE INTERRUPTIONS. OTHER ATMOSPHERIC PARAMETERS SUCH AS AEROSOLS ARE PERTINENT TO EROSION PROBLEMS AT HIGH SPEEDS, AND HAILSTONES (OR RAIN) CAUSE STRUCTURAL DAMAGE. BOTH EXPERIMENTAL AND ANALYTICAL STUDIES ARE MADE TO PROVIDE THE NEEDED ATMOSPHERIC DATA IN A USEFUL FORM FOR APPLICATION TO VEHICLE PROBLEMS. ATMOSPHERIC PARAMETERS ARE IMPORTANT IN SONIC BOOM AND NOISE PROPAGATION.

RTOP NO. 126-61-10 TITLE: ATMOSPHERIC PARAMETERS  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: EHERNBERGER, L. J. TEL. 805-258-3311  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK IS THE DEFINITION OF THE ATMOSPHERIC CONDITIONS IN WHICH TURBULENCE, TEMPERATURE, TRANSIENTS, POTENTIAL PRESSURE ALTIMETRY PROBLEMS, AND EXCESSIVE WIND SHEARS OCCUR. THE MAJOR EMPHASIS IN THE ATMOSPHERIC ENVIRONMENT OF SUPERSONIC AIRCRAFT. DEVELOPMENT AND ACQUISITION OF SENSORS NEEDED TO MEASURE THESE PHENOMENA ARE ALSO INCLUDED. RESULTS OF THIS WORK WILL BE APPLICABLE TO AIRCRAFT SYSTEMS DESIGN AS WELL AS FLIGHT OPERATIONS ROUTING AND SCHEDULING. OBSERVATIONS OF THESE PHENOMENA ARE OBTAINED FROM INSTRUMENTED AIRCRAFT TEST FLIGHTS. THE ASSOCIATED METEOROLOGICAL CONDITIONS ARE ANALYZED AND STUDIED BOTH IN-HOUSE AND ON-CONTRACT.

RTOP NO. 126-61-10 TITLE: SEVERE LOCAL STORMS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: MCGOWAN, W. A. TEL. 202-962-4601  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO IMPROVE OUR UNDERSTANDING OF THE MORPHOLOGY OF SEVERE LOCAL STORMS AND PROVIDE THE TECHNOLOGY FOR ADEQUATE AIRCRAFT DESIGN AND SAFE OPERATING PROCEDURES IN THE ENVIRONMENT. THEORETICAL ANALYSIS AND ATMOSPHERIC MEASUREMENTS USING INSTRUMENTED AIRCRAFT, METEOROLOGICAL TOWERS, BALLOONS AND RADARS WILL BE USED TO DEFINE THE PHYSICAL AND ELECTROMAGNETIC CHARACTERISTICS OF THE STORM. THE INFORMATION WILL PROVIDE THE METEOROLOGIST, AIRCRAFT DESIGNER, AND AIRCRAFT PILOT DATA FOR SAFE, ECONOMICAL OPERATIONS.

RTOP NO. 126-61-11 TITLE: AIRCRAFT OPERATING EXPERIENCES  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

STATISTICAL DATA ON THE OPERATIONAL EXPERIENCES OF COMMERCIAL PASSENGER AND CARGO TRANSPORTS, GENERAL AVIATION AIRPLANES, AND RESEARCH TYPE AIRPLANES ARE BEING COLLECTED AND ANALYZED. THE DATA ARE COLLECTED DURING ROUTINE OPERATIONS OF THE AIRPLANES BY USE OF NASA INSTRUMENTATION. THE DATA FROM THE COMMERCIAL AND GENERAL AVIATION AIRPLANES ARE OBTAINED THROUGH COOPERATIVE PROGRAMS WITH THE MANUFACTURERS, AIRLINES, AND PRIVATE OWNERS. THE DATA PROVIDE INFORMATION ON THE GROUND AND FLIGHT LOADS, AIRSPEED AND ALTITUDE OPERATING PRACTICES, THE TURBULENCE ENVIRONMENT, AND ON UNUSUAL EVENTS SUCH AS LOSS OF CONTROL IN TURBULENCE, COLLISION AVOIDANCE MANEUVERS, AND AUTOPILOT INDUCED MANEUVERS. THE INFORMATION OBTAINED PROVIDES A CONTINUED BASIS FOR COMPARING ACTUAL AIRPLANE OPERATIONS WITH THE CONCEPTS USED IN DESIGN, FOR DETECTING UNANTICIPATED OPERATIONAL ASPECTS, AND PROVIDES A RESERVOIR OF DATA USEFUL IN THE DESIGN AND DEVELOPMENT OF AIRWORTHINESS REQUIREMENTS FOR NEW TYPES OF AIRPLANES. JUSTIFICATION: A DETAILED KNOWLEDGE OF THE OPERATING PRACTICES, THE LOADS EXPERIENCED, AND THE OPERATIONAL ENVIRONMENT OF VARIOUS TYPES OF AIRPLANES DURING ROUTINE OPERATIONS IS REQUIRED FOR:

- A. THE CONTINUAL REASSESSMENT OF THE MINIMUM AIRWORTHINESS REQUIREMENTS FOR CURRENT AIRPLANES
- B. THE DEVELOPMENT OF AIRWORTHINESS REQUIREMENTS FOR NEW TYPES OF AIRPLANES AND TYPES OF OPERATIONS
- C. USE BY MANUFACTURERS IN THE DESIGN AND TESTING OF NEW AIRPLANES.

RTOP NO. 126-61-12 TITLE: TIRE TRACTION, BRAKING  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE PRESENCE OF WATER OR SLUSH ON PREPARED FIELDS AND THE TYPE OF SOIL ON UNPREPARED FIELDS CAN CONTRIBUTE TO UNSAFE HANDLING CONDITIONS DURING TAXIING, STOPPING, AND STEERING AIRCRAFT. ALSO THE ROUGHNESS OF HARD SURFACE AIRFIELDS, AND OBSTRUCTIONS SUCH AS

ARRESTING GEAR CABLES AND PLAT HEADS ON AIRCRAFT CARRIER DECKS CONTRIBUTE TO HIGH LANDING AND TAXIING LOADS. THE OBJECTIVE OF THESE INVESTIGATIONS ARE TO OBTAIN A FUNDAMENTAL UNDERSTANDING OF THESE PHENOMENA WITH A VIEW TOWARD THEIR SOLUTION. THIS WORK WILL BE APPLICABLE TO IMPROVED DESIGN OF AIRCRAFT LANDING GEARS AND BRAKING SYSTEMS AS WELL AS IMPROVEMENT IN RUNWAY DESIGN.

RTOP NO. 126-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 205-453-1120

TECHNICAL SUMMARY

TWO PHENOMENA, BOTH OF WHICH ARE TURBULENCE, WILL BE INVESTIGATED TO PROVIDE BASIC TECHNOLOGY DATA FOR THE IMPROVEMENT OF THE OPERATIONAL SAFETY OF CIVIL AND MILITARY AIRCRAFT FOR THE PREVENTION OF CATASTROPHIC ACCIDENTS. SPECIFICALLY, A GROUND BASED SYSTEM FOR THE DETECTION OF AIRCRAFT TRAILING VORTICES, AND AN AIRBORNE SYSTEM FOR THE DETECTION OF CLEAR AIR TURBULENCE (CAT) WILL BE DEVELOPED. THE PRIMARY EMPHASIS WILL BE PLACED ON THE DEVELOPMENT OF AN OPERATIONAL TRAILING VORTEX DETECTION SYSTEM. USING THE LASER HETERODYNE APPROACH, AN AIRBORNE CAT DETECTION SYSTEM WILL BE DEVELOPED INTO A FLYABLE SYSTEM. THE TOTAL SYSTEM WILL BE PROOF TESTED ON THE GROUND THEN UNDERGO FLIGHT TESTING. A SIMILAR APPROACH WILL BE USED IN THE DEVELOPMENT OF A SYSTEM TO MEASURE THE VORTICES CREATED BY FAST, LARGE AND HEAVY AIRCRAFT. BOTH TURBULENCE DETECTION SYSTEMS ARE REQUIRED FOR THE COMFORT AND SAFETY OF PASSENGERS AND CREWS. IN THE CASE OF THE CAT, IT IS BECOMING EVEN MORE IMPORTANT ESPECIALLY IN VIEW OF THE LARGE JUMBO JETS WHICH WILL CARRY HUNDREDS OF PASSENGERS ON A SINGLE FLIGHT. UNFORTUNATELY, THESE JUMBO JETS INCREASE THE PROBLEM OF TRAILING VORTEX TURBULENCE. IN THE PAST THE VORTEX PROBLEM CREATED HAZARDOUS CONDITIONS FOR "SMALL" AIRCRAFT ONLY; HOWEVER, WITH THE JUMBO JETS, THE VORTEX TURBULENCE PROBLEM NOW IS IMPOSED UPON WHAT WERE CONSIDERED TO BE "MEDIUM AND LARGER" AIRCRAFT.

RTOP NO. 126-61-13 TITLE: AIRCRAFT SAFETY

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO PROVIDE THE BASIC TECHNOLOGY FOR THE IMPROVEMENT OF OPERATIONAL SAFETY OF AIRCRAFT. INITIALLY THIS WORK WILL BE FOCUSED ON THE DEVELOPMENT OF IMPROVED MATERIALS FOR AIRCRAFT TIRES AND BRAKES. MATERIALS TO BE CONSIDERED OFFER PROMISE FOR IMPROVED PERFORMANCE AND GREATER OPERATIONAL SAFETY.

RTOP NO. 126-61-13 TITLE: AIRCRAFT OPERATING PROBLEMS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: CHIARITO, P. T. TEL. 216-433-4000  
TECHNICAL SUMMARY

OBJECTIVE: TO PROVIDE BASIC DATA FOR THE IMPROVEMENT OF THE OPERATIONAL SAFETY OF CIVIL AND MILITARY AIRCRAFT. APPROACH: THROUGH NASA SUPPORTED RESEARCH, WHICH COMPLEMENTS RESEARCHES CONDUCTED BY OTHER SEGMENTS OF THE AVIATION COMMUNITY, PROVIDE DEVICES AND TECHNIQUES WHICH OVERCOME OPERATIONAL PROBLEMS PRESENTED BY THE DESIRE TO IMPROVE THE SAFETY OF AIRPLANE OPERATIONS WHILE EXTENDING THE MISSION OF THE AIRPLANE AND IMPROVING THE ECONOMICS OF ITS OPERATION.

RTOP NO. 126-61-13 TITLE: HAZARD AVOIDANCE AND ELIMINATION  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE BASIC TECHNOLOGY DATA FOR THE IMPROVEMENT OF THE LEVEL OF SAFETY IN AIRCRAFT OPERATIONS. TECHNICAL ASSISTANCE IS BEING PROVIDED TO VARIOUS AGENCIES HAVING SAFETY OF FLIGHT PROBLEMS. METHODS OF DETECTING CLEAR AIR TURBULENCE ARE BEING INVESTIGATED. THE CHARACTERISTICS OF WING TRAILING VORTICES SHED AT HIGH ALTITUDES AND IN CLOSE PROXIMITY OF THE GROUND ARE BEING STUDIED.

RTOP NO. 126-61-14 TITLE: JET NOISE REDUCTION  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: MCDONALD, R. R. TEL. 213-354-6186  
TECHNICAL SUMMARY

THE GENERAL OBJECTIVES OF THIS TASK ARE TO DETERMINE (1) THE INFLUENCE OF VELOCITY DISTRIBUTION AT THE EXIT OF A NOZZLE, AND (2) THE INFLUENCE OF TURBULENCE, PARTICULARLY IN THE BOUNDARY LAYER, ON THE NOISE RADIATED FROM SUPERSONIC JETS DISCHARGING INTO THE ATMOSPHERE AT STAGNATION TEMPERATURES OF THE ORDER OF 3000 DEGREES F. UNDERSTANDING THE MECHANISM OF NOISE GENERATION FROM SUCH JETS IS ESSENTIAL TO NOISE REDUCTION FROM TURBOJET ENGINES USED ON AIRCRAFT -- PARTICULARLY AS APPLIED TO THE AFTERBURNING ENGINE OF THE SUPERSONIC TRANSPORT. AN UPSTREAM APPROACH SECTION IN WHICH TURBULENCE LEVELS AND GAS TEMPERATURES ARE ADJUSTABLE, TOGETHER WITH SUPPORT EQUIPMENT WILL BE DESIGNED, FABRICATED AND INSTALLED. IN ADDITION, MEASUREMENTS OF PRESSURE AND TEMPERATURE DISTRIBUTIONS AT THE EXIT PLANE OF THE SUPERSONIC EXHAUST OF A LARGE ROCKET ENGINE OPERATING AT CONDITIONS SIMULATING THE SUPERSONIC JET OF A TURBOJET WILL BE OBTAINED AND CORRELATED WITH VARIATIONS IN UPSTREAM ROUGHNESS - I.E., TURBULENCE - AND FAR-FIELD SOUND INTENSITIES. EXPERIMENTAL MEASUREMENTS OF THE PERCEPTIVE NOISE LEVEL WILL BE MADE AT SELECTED LOCATIONS IN THE SURROUNDINGS OF JETS EMERGING FROM A ROCKET NOZZLE AND A NOZZLE CONTAINING HEATED AIR FLOW. VELOCITY DISTRIBUTIONS IN JETS WILL BE DETERMINED FROM MEASUREMENTS OF PRESSURES AND TEMPERATURES OBTAINED WITH PROBES. PRESSURE FLUCTUATIONS WILL BE MEASURED WITH GAGES. OTHER METHODS OF DETERMINING FLUCTUATING



QUANTITIES WILL BE INVESTIGATED. FOR THE HEATED AIR TESTS COMPRESSED AIR WILL BE SUPPLIED BY AN EXISTING COMPRESSED AIR FACILITY AT PRESSURES ENCOUNTERED IN JET ENGINES AND THE AIR WILL BE HEATED BY BURNING A JET FUEL TO TEMPERATURES ALSO ENCOUNTERED IN TURBOJET ENGINES. ROCKET ENGINE TESTS WILL BE CONDUCTED USING SUPERSONIC NOZZLES WITH AN EXIT DIAMETER OF ABOUT 12-IN. AND FLOW CONDITIONS RESEMBLING THOSE OF JET ENGINES. NOISE LEVEL AND PRESSURE FLUCTUATIONS WILL BE MEASURED.

RTOP NO. 126-61-14 TITLE: ENGINE AND PROPELLER NOISE  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: MCLEOD, M. J. TEL. 805-258-3311

TECHNICAL SUMMARY

THE PRIMARY OBJECTIVES OF THESE STUDIES ARE TO MEASURE AND EVALUATE NEAR- AND FAR FIELD ACOUSTIC DATA, AND CORRELATE WITH PREDICTION TECHNIQUES TO AID IN THE CONTROL OF ACOUSTIC PHENOMENA FOR PRESENT AND FUTURE AEROSPACE VEHICLES. THESE INCLUDE STUDIES OF ENGINE NOISE DURING TAKEOFF AND LANDING, AND ITS EFFECTS ON THE VEHICLE AND THE VEHICLE'S SURROUNDINGS, AND BOUNDARY-LAYER NOISE AT VARIOUS FLIGHT CONDITIONS.

RTOP NO. 126-61-14 TITLE: ENGINE AND PROPELLER NOISE  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: KRAMER, J. J. TEL. 216-433-4000

TECHNICAL SUMMARY

THE WORK IN THIS PROGRAM IS DIRECTED AT OBTAINING AN UNDERSTANDING OF THE DOMINANT NOISE SOURCES IN AIRCRAFT TURBINE ENGINES. THE CURRENT PROGRAM ACTIVITY IS CENTERED ON FAN AND JET NOISE GENERATION AND TRANSMISSION AND SUPPRESSION OF THIS NOISE IN DUCTS. PROSPECTS FOR OVERALL FAN AND JET NOISE LEVEL REDUCTIONS OF 15-20 DB FROM CURRENT LEVELS ARE GOOD. IF THESE NOISE REDUCTIONS ARE REALIZED OTHER NOISE SOURCES IN THE ENGINE MAY BE UNCOVERED. THE RESEARCH EMPHASIS WOULD THEN BE SHIFTED TO THESE OTHER NOISE SOURCES. NOISE GENERATED IN THE TURBINE AND IN THE FLOW OVER STRUTS UPSTREAM OF THE NOZZLE IS LIKELY TO BE UNCOVERED BY REDUCED NOISE OUTPUT FANS AND JETS.

RTOP NO. 126-61-14 TITLE: ENGINE AND PROPELLAR NOISE  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: KRAMER, J. J. TEL. 205-453-1120

TECHNICAL SUMMARY

A TRANSPORTABLE CROSSED-BEAM SYSTEM FOR ON-SITE INVESTIGATIONS OF MODEL AND FULL-SCALE ROCKET AND/OR AIRCRAFT ENGINES WILL BE DEVELOPED. THIS SYSTEM(S) WILL BE USED IN CONJUNCTION WITH ALREADY EXISTING ADVANCED DATA PROCESSING AND ADVANCED STATISTICAL ANALYSIS TECHNIQUES TO CONDUCT JET NOISE RESEARCH TO DETERMINE FUNDAMENTAL KNOWLEDGE ON GENERATION MECHANICS AND SUPPRESSION TECHNIQUES. FUNDAMENTAL FLUID DYNAMICS RELATIONSHIPS WILL BE INVESTIGATED AND

MODIFIED (IMPROVED). THIS WILL RESULT IN NOISE ABATEMENT PROCEDURES THAT ARE EFFECTIVE WHICH WILL REDUCE HEALTH HAZARDS, ANNOYANCES AND PROPERTY DAMAGE.

RTOP NO. 126-61-14 TITLE: ENGINE AND PROPELLER NOISE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE ACCOMPLISHED BY THE FOLLOWING: (A) IDENTIFICATION AND EVALUATION OF THE SOURCES OF NOISE THAT ARE SIGNIFICANT UNDER VARIOUS OPERATING CONDITIONS OF JET ENGINES (INCLUDING EXHAUST JETS, FANS, COMPRESSORS, AND TURBINES) AND PROPELLERS (WITH AND WITHOUT DUCTS), WITH A VIEW TOWARD NOISE REDUCTION AT THE SOURCE BY DESIGN. SUCH FACTORS AS JET VELOCITY, TEMPERATURE, DENSITY AND TURBULENCE LEVEL; TIP SPEED, NUMBER OF BLADES, INFLOW ANGLES, SECTION CHARACTERISTICS, SURFACE ROUGHNESSES WAKE INTERACTIONS, ETC. FOR PROPELLERS, FANS, COMPRESSORS AND TURBINES WILL BE STUDIED TO DETERMINE THEIR EFFECTS ON THE GENERATED NOISE; (B) NOISE REDUCTION BY MEANS OF THE APPLICATION OF ACOUSTIC MATERIALS IN THE INLET, IN THE FAN DISCHARGE DUCTS, IN THE MAIN EXHAUST DUCT OF AN ENGINE OR BY THE APPLICATION OF JET EXHAUST NOISE SUPPRESSOR; (C) IDENTIFICATION AND EVALUATION OF THOSE FACTORS SIGNIFICANT IN THE ATTENUATION OF NOISE DURING PROPAGATION FROM AIR TO GROUND OR FROM GROUND TO GROUND SITUATIONS; (D) DEVELOPMENT OF A PECTRA FROM AIRCRAFT POWER PLANTS UNDER VARIOUS OPERATING CONDITIONS AND AT VARIDEQUATE METHODS OF PREDICTION OF NOISE SOUS DISTANCES. THIS WORK WILL BE ACCOMPLISHED BY MEANS OF THEORETICAL STUDIES, BY FULL-SCALE AIRCRAFT TESTS AND BY MODEL TESTS IN WIND TUNNELS AND SPECIAL TEST CELLS.

RTOP NO. 126-61-15 TITLE: SONIC BOOM EFFECTS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO IDENTIFY AND TO QUANTIFY THE DETRIMENTAL EFFECTS OF NOISE AND SONIC BOOMS ON GROUND BASED STRUCTURES AND EQUIPMENT IN ORDER THAT DESIGN AND OPERATIONAL PROCEDURES MAY BE DEvised TO MINIMIZE SUCH EFFECTS. THE EMPHASIS IS ON BUILDING STRUCTURES FOR WHICH VIBRATIONS, NOISE TRANSMISSION AND SUPERFICIAL DAMAGES DUE TO REPEATED LOADS, ARE OF PARTICULAR CONCERN.

THE DEVELOPMENT OF SIMULATORS IS ALSO INCLUDED. THIS WORK WILL BE ACCOMPLISHED BY MEANS OF THEORETICAL STUDIES, AS WELL AS BOTH MODEL COMPONENT AND FULL-SCALE TESTS INVOLVING AIRPLANE FLYOVERS, LABORATORY ACOUSTICAL EXCITATION AND THE USE OF SIMULATORS.

RTOP NO. 126-61-16 TITLE: EVALUATION AND DEVELOPMENT OF FLIGHT  
RESEARCH SENSORS.

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: WEBB, L. D. TEL. 805-258-3311

TECHNICAL SUMMARY

THE ADVANCED TYPE RESEARCH FLIGHTS BEING CONDUCTED AT FRC REQUIRES THE USE OF NEW AND UNPROVEN TYPES OF SENSORS TO OBTAIN THE DESIRED RESEARCH MEASUREMENTS. THE OBJECTIVE OF THIS PROGRAM IS THE DESIGN DEVELOPMENT AND TESTING OF ADVANCED SENSORS PARTICULARLY WHEN THE WORK IS BEING DONE IN ADVANCE OF, OR APART FROM, THE VEHICLE ON WHICH IT WILL ULTIMATELY BE USED. EXAMPLES OF NEEDED SENSORS ARE ALTIMETERS FOR USE AT HIGH SPEEDS AND EXTREME ALTITUDES, MINIATURE PRESSURE TRANSDUCERS CAPABLE OF WITHSTANDING MACH 3 STAGNATION TEMPERATURES, PRESSURE SURVEY RAKES SUITABLE FOR MEASURING DYNAMIC FLOWS, AND MINIATURE FLOW DIRECTION SENSORS FOR DETERMINING LOCAL FLOW ANGULARITIES. WHENEVER POSSIBLE "OFF-THE-SHELF" ITEMS WILL BE USED WITH FLIGHT SUITABILITY BEING DETERMINED IN FRC LABS. DEVELOPMENT OF NEW CONCEPTS WILL BE SPONSORED IF NO AVAILABLE DEVICES SUIT THE NEEDS.

RTOP NO. 126-61-16 TITLE: INSTRUMENTATION

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

NEW CONCEPTS, TECHNIQUES, AND ADVANCED TECHNOLOGY WILL BE INVESTIGATED AND DEVELOPED TO IMPROVE, REPLACE, OR TO FILL VOIDS IN RESEARCH INSTRUMENTATION TECHNIQUES AND SYSTEMS REQUIRED FOR THE STUDY OF PROBLEMS RELATING TO EFFICIENT AND SAFE OPERATION OF ALL CLASSES OF AIRCRAFT. EFFORT WILL BE CONCENTRATED IN COLLISION-HAZARD WARNING, CLEAR-AIR TURBULENCE DETECTION AND WARNING, PILOT DISPLAYS, SENSORS, AND DATA SYSTEMS.

RTOP NO. 126-61-18 TITLE: APPLICATION OF MET. SATELLITE DATA TO THE  
SUPERSONIC TRANSPORT

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 205-453-1120

TECHNICAL SUMMARY

THE EVENTUAL PURPOSE OF WEATHER SATELLITES, SUCH AS NIMBUS, IS TO OBTAIN GLOBAL WEATHER DATA FROM REGIONS WITHOUT SURFACE STATIONS. TIROS VII AND NIMBUS II 15-MICRON DATA HAVE ALREADY BEEN SUCCESSFULLY USED TO OBTAIN STRATOSPHERIC TEMPERATURE PATTERNS, AND EVEN TO DETECT STRATOSPHERIC WARMINGS. BECAUSE THE 15-MICRON EQUIVALENT BLACK BODY TEMPERATURE CAN BE INTERPRETED AS A MEAN TEMPERATURE IN THE VERTICAL DIMENSION, IT IS REASONABLE TO EXPECT A RELATIONSHIP BETWEEN THAT QUANTITY AND THE THICKNESS BETWEEN GEOPOTENTIAL HEIGHTS OF TWO PRESSURE LEVELS. IT HAS BEEN SHOWN THAT A CORRELATION IN LONGITUDE EXISTS AT A GIVEN LATITUDE BETWEEN THE THICKNESS FROM 100 TO 10 MB AND THE TIROS VII 15-MICRON EQUIVALENT BLACK BODY TEMPERATURES. IF A FIRM RELATIONSHIP CAN BE ESTABLISHED BETWEEN THICKNESS AND THE 15-MICRON TEMPERATURE, THE GEOPOTENTIAL HEIGHT FIELD AT A

STRATOSPHERIC LEVEL COULD BE ESTIMATED FROM THE 15-MICRON-DERIVED THICKNESS AND THE HEIGHT FIELD AT SOME LOWER COMMONLY AVAILABLE LEVEL. THE PURPOSE OF THE PROPOSED RESEARCH IS THEREFORE TO INVESTIGATE THE RELATIONSHIP BETWEEN THE 15-MICRON TEMPERATURE AND THICKNESS PATTERNS AND TO FIND TECHNIQUE FOR UTILIZING THIS RELATIONSHIP IN THE PREPARATION OF GLOBAL TEMPERATURE AND HEIGHT MAPS.

RTOP NO. 126-62-10 TITLE: HANDLING QUALITIES  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: REDISS, H. A. TEL. 805-258-3311  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO STUDY AND DOCUMENT THE RELATIONSHIP BETWEEN THE STABILITY AND CONTROL CHARACTERISTICS OF AIRPLANES IN GENERAL AND THE PILOT'S ASSESSMENTS OF THE HANDLING QUALITIES, THROUGH THE USE OF SIMULATORS (BOTH FIXED-BASED AND AIRBORNE) AND THE ACTUAL AIRPLANES.

RTOP NO. 126-62-10 TITLE: HANDLING QUALITIES  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

TO STUDY ANALYTICALLY AND BY THE USE OF FLIGHT SIMULATORS THE HANDLING QUALITIES (ASSOCIATED WITH VEHICLE DYNAMICS AND CONTROL EFFECTIVENESS) AND CONTROL SYSTEMS OF PROPOSED SUPERSONIC AND TACTICAL AIRCRAFT AND OTHER AEROSPACE VEHICLES. TO INCLUDE ANALOG SIMULATIONS AND THEORETICAL ANALYSES OF THE AERIAL COMBAT PROBLEM AND THE CONTROL OF AIRCRAFT IN TURBULENCE. ALL OF THESE INVESTIGATIONS ARE DESIGNED TO EXPAND FUNDAMENTAL KNOWLEDGE ON AIRCRAFT HANDLING QUALITIES AS THEY ARE IMPORTANT TO THE ADVANCEMENT OF AERODYNAMIC FLIGHT.

RTOP NO. 126-62-10 TITLE: HANDLING QUALITIES AND FLIGHT DYNAMICS  
THEORY  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: KLEIN, H. P. TEL. 415-961-1111  
TECHNICAL SUMMARY

PREVIOUS GENERAL VIBRATION AND JOSTLING STUDIES ON HUMANS AND SPECIFIC STUDIES OF THE "JET-UPSET" PROBLEMS HAVE INDICATED THAT HUMAN PERFORMANCE AND COMFORT ARE ADVERSELY AFFECTED BY THE VIBRATION OR JOSTLE ENVIRONMENT. UNFORTUNATELY, THE RESULTS OF THESE PAST STUDIES ARE NOT OF TOO MUCH VALUE FOR PREDICTING PILOT CONTROL PERFORMANCE PROBLEMS FOR SPECIFIC COCKPIT VIBRATION ENVIRONMENTS. THIS SITUATION PREVAILS FOR SEVERAL REASONS (A) MANY OF THE PAST STUDIES WERE CONDUCTED BY PSYCHOLOGISTS OR PHYSIOLOGISTS SO THAT THE PERFORMANCE MEASURES USED WERE NOT APPLICABLE OR APPROPRIATE TO SPECIFIC AIRCRAFT PROBLEMS; AND (B) IN STUDIES WHERE SPECIFIC AIRCRAFT PROBLEMS WERE INVESTIGATED, E.G., NASA JET UPSET RESEARCH, INSUFFICIENT INFORMATION WAS OBTAINED TO ESTABLISH WHY PERFORMANCE DETERIORATED FOR CERTAIN

TASKS UNDER JOSTLING CONDITIONS. WE PLAN, ACCORDINGLY, TO CARRY OUT A SERIES OF RESEARCH STUDIES TO INVESTIGATE, SYSTEMATICALLY, PILOT CONTROL AND INSTRUMENT MONITORING "PROBLEMS" AS AFFECTED BY VIBRATION AND JOSTLING. THE LATTER WILL BE TAILORED TO INCLUDE COCKPIT ENVIRONMENTS ASSOCIATED WITH CURRENT AND FUTURE CLASSES OF COMMERCIAL JET TRANSPORTS. INTERNAL STUDIES WILL BE CARRIED OUT ON THE AMES VERTICAL ACCELERATION AND ROLL DEVICE TO DETERMINE THE EFFECTS OF VEHICLE AND DYNAMICS ON PILOT CONTROL PERFORMANCE FOR SELECTED LEVELLS AND FREQUENCIES OF VERTICAL VIBRATION. SUBSEQUENT TESTS, BOTH IN HOUSE AND BY CONTRACT, WILL EXTEND OUR RESEARCH TO INCLUDE LATERAL VIBRATION EFFECTS, MORE SOPHISTICATED FLIGHT TASKS, VIBRATION ISOLATION SEAT SYSTEMS AND MODIFIED DISPLAY/CONTROL SYSTEMS.

RTOP NO. 126-62-10 TITLE: HANDLING QUALITIES  
ORGANIZATION: HEADQUARTERS  
MONITOR: WASICKO, R. J. TEL. 202-962-4601  
TECHNICAL SUMMARY

THE OBJECTIVES OF WORK ARE (1) TO DETERMINE THE EFFECTS OF AND THE IMPORTANT PARAMETERS RELATED TO ATMOSPHERIC TURBULENCE ON PILOT CONTROLLABILITY AND HANDLING QUALITIES; AND (2) TO DEVELOP A PROCEDURE FOR ASSESSING TURBULENCE-PENETRATION PERFORMANCE OF THE PILOT/AIRCRAFT/CONTROL SYSTEM COMBINATION. ATMOSPHERIC TURBULENCE IS KNOWN TO HAVE A DETRIMENTAL EFFECT ON PATH PERFORMANCE IN CLOSELY CONSTRAINED SITUATIONS AND HAS CONTRIBUTED TO LOSS OF CONTROL IN HIGH SPEED FLIGHT. HOWEVER, EXISTING QUANTITATIVE DATA ON THE RELATIONSHIPS BETWEEN TURBULENCE PARAMETERS AND HANDLING QUALITIES IS INADEQUATE TO PERMIT PROPER CONSIDERATION OF TURBULENCE IN AIRCRAFT DESIGN AND IN ESTABLISHING OPERATIONAL PROCEDURES. THIS WORK, INVOLVING ANALYSIS AND EXPERIMENTS WITH A VARIABLE STABILITY AIRCRAFT, IS APPLICABLE TO A WIDE RANGE OF AIRCRAFT FROM SMALL GENERAL AVIATION AIRPLANES TO LARGE COMMERCIAL JET TRANSPORTS.

RTOP NO. 126-62-11 TITLE: FLIGHT DYNAMICS-THEORY  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: REDISS, H. A. TEL. 805-258-3311  
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS EFFORT IS TO ADVANCE THE FUNDAMENTAL KNOWLEDGE OF FLIGHT DYNAMICS AND TO EXPLOIT THIS KNOWLEDGE TO DEVELOP METHODS FOR OPTIMIZING SPECIFIC FLIGHT CONTROL OR PERFORMANCE GOALS AND TO IMPROVE FLIGHT TEST ANALYSIS TECHNIQUES. ANALYTICAL STUDIES, COMPUTER SIMULATIONS AND FLIGHT TEST INVESTIGATIONS ARE BEING PERFORMED BOTH IN-HOUSE AND UNDER RESEARCH CONTRACTS AND GRANTS TO MEET THIS OBJECTIVE.

RTOP NO. 126-62-11 TITLE: DYNAMIC STABILITY AND CONTROL  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE BROAD OBJECTIVE IS TO EXPAND FUNDAMENTAL KNOWLEDGE OF THE DYNAMIC STABILITY AND CONTROL CHARACTERISTICS OF AIRCRAFT, INCLUDING SPINNING, AND TO DETERMINE THE EFFECTS OF THESE CHARACTERISTICS IN TERMS OF PILOTING THE AIRCRAFT. SPECIFIC OBJECTIVES ARE TO INVESTIGATE THE FUNDAMENTAL NATURE OF THE SPIN, INCLUDING THE DEVELOPMENT OF METHODS FOR THEORETICAL ANALYSIS, AND TO INVESTIGATE THE PROBLEMS BROUGHT ON BY OPERATION OUTSIDE THE NORMAL FLIGHT ENVELOPE, BY OPERATION IN SEVERE CONDITIONS SUCH AS TURBULENCE, AND BY DEVIATIONS FROM CONFIGURATION NORMS. THE METHODS OF APPROACH ARE THEORETICAL ANALYSIS, PILOTED SIMULATOR STUDIES, AND DYNAMIC MODEL TESTS.

RTOP NO. 126-63-10 TITLE: AIRCRAFT OPERATIONAL SUPPORT  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

MAINTENANCE AND OPERATION OF AIRCRAFT FOR RESEARCH AND DEVELOPMENT, PROFICIENCY, CHASE AND GENERAL RESEARCH AND DEVELOPMENT SUPPORT

RTOP NO. 126-63-10 TITLE: AIRCRAFT OPERATIONAL SUPPORT  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: WHITESIDE, W. W. TEL. 805-258-3311  
TECHNICAL SUMMARY

MAINTENANCE AND OPERATION IS PROVIDED FOR ALL AIRCRAFT SYSTEMS, INCLUDING INSTRUMENTATION, FOR THE FOLLOWING AIRCRAFT: TWO F-104A'S, F-104B, TWO F-104N'S, TWO F-8A'S, F-5D, T-33A, C-47, B-57 AND AERO COMMANDER. THESE EFFORTS ARE ACCOMPLISHED MAINLY IN-HOUSE, WITH ASSISTANCE AS REQUIRED BY SUPPORT PROVIDED BY THE MILITARY SERVICES AND BY CONTRACTORS. THIS EFFORT IS REQUIRED TO PROVIDE FOR ADEQUATE PILOT PROFICIENCY, CHASE AIRCRAFT SUPPORT, R AND D SUPPORT OF RESEARCH INVESTIGATIONS AND GENERAL AIRCRAFT OPERATIONAL SUPPORT TO PERMIT CONTINUATION OF A BROAD-BASED AIRCRAFT AND SPACE TECHNOLOGY PROGRAM.

RTOP NO. 126-63-10 TITLE: AIRCRAFT OPERATIONAL SUPPORT  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: BEHEIM, M. TEL. 216-433-4000  
TECHNICAL SUMMARY

LEWIS-BASED AIRCRAFT, INCLUDING RESEARCH AIRPLANES, TRANSPORTS, AND CHASE PLANES MUST BE SERVICED, MODIFIED, AND MAINTAINED IN FLIGHTWORTHY STATUS. MANPOWER AND FUNDING ESTIMATED FOR THIS PURPOSE ARE ALLOCATED IN THIS RTOP. 14. JUSTIFICATION. C-47 AND T-29 AIRCRAFT BASED AT THIS CENTER ARE USED TO TRANSPORT PERSONNEL AND



CARGO IN SUPPORT OF CENTER PROGRAMS AS WELL AS THE PROGRAMS OF OTHER NASA CENTERS AND NASA HEADQUARTERS. THE F-106 AIRPLANE IS USED FOR RESEARCH FLIGHT TESTS OF INLETS, NOZZLES, AND CONTROLS AS DESCRIBED IN RTOP'S 720-03-10 AND 720-03-11. 15. TECHNICAL PLAN. AIRCRAFT SERVICING, MODIFICATION, AND MAINTENANCE SPECIFIED IN MILITARY TECH ORDERS, MANUFACTURERS' BULLETINS, FAA ISSUANCES, AND OTHER REGULATORY DOCUMENTS WILL BE PERFORMED AS REQUIRED. ITEMS COVERED IN THE ESTIMATED FUNDS INCLUDE: AIRCRAFT AND ENGINE REPLACEMENT PARTS, FUELS AND LUBRICANTS, AND MISCELLANEOUS EXPENDABLE ITEMS SUCH AS PYROTECHNICS AND PARACHUTES. 16. REVIEW AND REPORTING. NO SPECIAL ARRANGEMENTS. 17. TARGET SCHEDULE. NONE.

RTOP NO. 126-63-10 TITLE: AIRCRAFT OPERATIONAL SUPPORT  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

RESEARCH FLIGHT INVESTIGATIONS ARE CONDUCTED USING THE FOLLOWING TEST AIRCRAFT: CONVAIR 340 LEAR JET F-100C PROVISION MUST BE MADE FOR MAINTENANCE AND OPERATING COSTS FOR THESE AIRCRAFT.

RTOP NO. 126-63-11 TITLE: TITLE SUPPORT OF OTHER GOVERNMENT AGENCY  
AND INDUSTRY AERODYNAMIC TESTING  
REQUIREMENTS

ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

WITH DUE CONSIDERATION OF AVAILABLE MANPOWER, FUNDS, AND OBLIGATIONS TOWARDS NASA RESEARCH AND PROJECTS, AMES SUPPORTS OTHER GOVERNMENTAL AGENCY AND INDUSTRY PROGRAMS IN AERONAUTICS. THE SUPPORT CONSISTS OF CONSULTATION, ASSIGNMENT OF PERSONNEL TO ADVISORY COMMITTEES OR BOARDS, AND THE CONDUCT OF TESTS IN WIND TUNNELS, OR OTHER FACILITIES. THE MAJOR PORTION OF THIS EFFORT IS IN SUPPORT OF THE DEPARTMENT OF DEFENSE ALTHOUGH THE ADVENT OF THE SUPERSONIC TRANSPORT HAS INCREASED THE ALLOTMENT OF TIME TO OTHER GOVERNMENTAL AGENCIES (IN PARTICULAR, THE DEPARTMENT OF TRANSPORTATION) CONSIDERABLY. IN GENERAL, MANPOWER AND TEST TIME IS ALLOCATED ONLY WHEN THE NEED FOR SPECIAL UNIQUE CAPABILITIES OF THE PERSONNEL OR THE EQUIPMENT IS EVIDENT, AND THE REQUEST IS IN THE NATIONAL INTEREST.

RTOP NO. 126-63-11 TITLE: RESEARCH SUPPORT OF OTHER ORGANIZATIONS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE NASA HAS A UNIQUE AERODYNAMIC TEST CAPABILITY REPRESENTED AT THE LANGLEY RESEARCH CENTER BY A NUMBER OF LARGER WIND TUNNELS AND UNIQUE STRUCTURAL AND PROPULSIVE TEST APPARATUS. THESE FACILITIES ARE USED TO PROVIDE WIND TUNNEL TEST SUPPORT AND RELATED AERODYNAMIC PROPULSIVE AND STRUCTURAL FACILITY TECHNICAL SUPPORT OF OTHER

GOVERNMENT AGENCIES INCLUDING BOTH GOVERNMENT SPONSORED AND PRIVATE R AND D ON AERONAUTICAL VEHICLE SYSTEMS. INVESTIGATIONS ARE CONDUCTED AS REQUIRED AT THE REQUEST OF THE COGNIZANT AGENCY; FOR EXAMPLE FOR THE DOD IN THE DEVELOPMENT OF NEW MILITARY AIRCRAFT AND MISSILE SYSTEMS; FOR DOT IN SUPPORT OF THE SST PROGRAM, OR FOR DOT IN R AND D ON HIGH-SPEED GROUND TRANSPORTATION.

RTOP NO. 126-63-11 TITLE: RESEARCH SUPPORT OF OTHER ORGANIZATIONS  
ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: LOGAN, W. O., JR. TEL. 216-433-4000

TECHNICAL SUMMARY

WHERE APPROPRIATE, THE UNIQUE CAPABILITIES OF LEWIS RESEARCH CENTER STAFF AND FACILITIES WILL BE EMPLOYED TO ASSIST OTHER ORGANIZATIONS IN THE FURTHERANCE OF AERONAUTICAL TECHNOLOGY. ORGANIZATIONS SUCH AS THE DEPARTMENT OF DEFENSE, DEPARTMENT OF TRANSPORTATION, FEDERAL AVIATION ADMINISTRATION AND VARIOUS PRIVATE INDUSTRIAL ORGANIZATIONS MAY BE GIVEN ASSISTANCE WHERE THEIR OBJECTIVES CAN BE INTERRELATED WITH CENTER PROGRAMS.

PTOP NO. 126-63-12 TITLE: UPDATING AND SUPPORT OF AERODYNAMIC FACILITIES

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

TECHNICAL SUMMARY

IN CONDUCTING AERONAUTICAL RESEARCH IN WIND TUNNELS IT IS NECESSARY TO CARRY ON A CONTINUOUS REVIEW OF THE EQUIPMENT AND INSTRUMENTATION EMPLOYED, AND ALSO THE TESTING TECHNIQUES, IN ORDER TO MAINTAIN AND REPLACE ITEMS, AND IN ORDER TO INCORPORATE NEW EQUIPMENT AND CONCEPTS INTO THE OPERATION WHENEVER THEY PROVE DESIRABLE. THE INCREASING DEMAND FOR WIND TUNNEL TEST TIME, PARTICULARLY IN THE TRANSONIC SPEED RANGE, OBLIGATES WIND TUNNEL OPERATORS TO MAKE MAXIMUM USE OF THE AVAILABLE TEST HOURS, RESULTING IN A CONSTANT SEARCH FOR APPARATUS OR METHODS THAT WILL PRODUCE MORE DATA PER TEST HOUR.

RTOP NO. 126-63-12 TITLE: UPDATING AND SUPPORT OF TEST FACILITIES  
ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

TO MAINTAIN THE CAPABILITIES AND OPERATIONAL EFFICIENCY OF EXISTING WIND TUNNEL AND STRUCTURAL TEST FACILITIES VITAL TO CONTINUING NASA AND GOVERNMENT-WIDE RESEARCH AND DEVELOPMENT NEEDS. UPDATE AUXILIARY EQUIPMENT AND INSTRUMENTATION AS REQUIRED TO INCREASE QUALITY AND SCOPE OF DATA OBTAINABLE. PROVIDE ADVANCED DATA ACQUISITION, REDUCTION, AND READOUT SYSTEMS.

RTOP NO. 126-63-12 TITLE: UPDATING AND SUPPORT OF TEST  
FACILITIES--HEAT FACILITY

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: ROSECRANS, R. J. TEL. 805-258-3311

TECHNICAL SUMMARY

AS PRESENT AND FUTURE VEHICLES REACH HIGHER-STRUCTURAL TEMPERATURES, THE RELIABILITY OF PRESENT METHODS FOR DETERMINING THE STRUCTURAL RESPONSES WILL DECREASE; AND NEW AND DIFFERENT CONFIGURATIONS AND MATERIALS WILL PRESENT MORE DIFFICULT PROBLEMS OF LOAD AND STRESS DETERMINATION. THE HIGH TEMPERATURE LOADS CALIBRATION LABORATORY IS BEING USED FOR STRUCTURAL TESTS LOADS CALIBRATIONS, AND DEFLECTION MEASUREMENTS OF PRESENT AND FUTURE HIGHPERFORMANCE VEHICLES. THE OBJECTIVES OF THIS TASK ARE TO PROVIDE THE PROFESSIONAL AND TECHNICAL SUPPORT NECESSARY FOR THE OPERATION OF THE FACILITY AND ITS SUPPORT EQUIPMENT. SUPPORT FOR THE LABORATORY INVOLVES PLANNING AND SCHEDULING OF TESTS, DESIGN AND FABRICATION OF TEST FIXTURES AND JIGS, INSTALLATION AND CHECKOUT OF RADIANT HEATERS, LOADING AND INSTRUMENTATION EQUIPMENT, OPERATION OF TEST AND DATA ACQUISITION EQUIPMENT, AND ACQUISITION, REDUCTION, AND ANALYSIS OF MECHANICAL AND THERMAL-LOADS DATA. PROCUREMENT OF NECESSARY MATERIALS AND EQUIPMENT IS ALSO REQUIRED AND INVOLVES SPECIFICATION PREPARATION, PROPOSAL EVALUATION, AND TESTING FOR VERIFICATION OF SPECIFICATIONS.

RTOP NO. 126-63-12 TITLE: UPDATING & SUPPORT OF TEST FACILITIES

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: LOGIN, W. O., JR. TEL. 216-433-4000

TECHNICAL SUMMARY

TO PROVIDE MAXIMUM CAPABILITY FOR PROPULSION RESEARCH WITH EXISTING EXPERIMENTAL FACILITIES, A PROGRAM TO MODERNIZE AND REFINE THE CENTER'S PROPULSION TEST STANDS AND LABORATORIES, AND DEVELOP MORE EFFICIENT EXPERIMENTAL TECHNIQUES IS DESCRIBED. FACILITY IMPROVEMENTS AND INSTRUMENTATION PROCEDURES OTHER THAN THOSE ASSOCIATED WITH SPECIFIC TASKS WILL BE IMPLEMENTED UNDER THIS RTOP. ALSO INCLUDED IS PROCUREMENT OF MODERN INSTRUMENTS AND EQUIPMENT, OR OVERHAUL AND UPGRADING OF OLDER ITEMS WHICH ARE STILL SERVICEABLE BUT INEFFICIENT BY PRESENT-DAY STANDARDS.

RTOP NO. 126-63-13 TITLE: SIMULATORS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: SMITH, J. P. TEL. 805-258-3311

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PROVIDE AND OPERATE THE NECESSARY SIMULATION FACILITIES AND EQUIPMENT TO SUPPORT FLIGHT DYNAMICS RESEARCH. THIS OBJECTIVE WILL BE ACCOMPLISHED BY THE ANALYSIS OF PROGRAM REQUIREMENTS, AND THE DESIGN, DEVELOPMENT, CONSTRUCTION, MAINTENANCE AND REPAIR OF THE REQUIRED SIMULATION FACILITIES AND EQUIPMENT.

RTOP NO. 126-63-13 TITLE: SIMULATORS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

TO UPGRADE AND SUPPORT THE OPERATION OF SIMULATION FACILITIES USED IN FLIGHT DYNAMICS AND MANNED FLIGHT CONTROL AND GUIDANCE RESEARCH. ANALYZE, DESIGN, DEVELOP, CONSTRUCT, CHECKOUT, TEST, VALIDATE, MAINTAIN, REPAIR, CONVERT, AND INSPECT THE SIMULATION FACILITIES AT LRC USED IN AERODYNAMIC RESEARCH.

RTOP NO. 126-63-13 TITLE: SIMULATORS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

RESEARCH IS BEING CARRIED OUT TO DETERMINE THE EFFECT OF VARIATIONS IN FLIGHT SIMULATOR FIDELITY OR CONFIGURATION ON THE EFFECTIVENESS OF THESE DEVICES FOR RESEARCH OR TRAINING. VARIOUS OUT-THE-WINDOW DISPLAY CONFIGURATIONS USING THE GENERAL PRECISION INSTRUMENTS, LTD. COLOR TVDISPLAY SYSTEM, ARE BEING STUDIED TO DEVELOP GUIDELINES FOR UPGRADING EXISTING SYSTEMS AND FOR ESTABLISHING NEEDS AND SPECIFICATIONS FOR NEW SYSTEMS IN A STUDY JUST COMPLETED, A COLLIMATED TV COLOR MONITOR DISPLAY CONFIGURATION WAS SHOWN TO BE AS EFFECTIVE AS THAT WHERE THE VISUAL SCENE IS PROJECTED ON A SCREEN. WE ARE ALSO STUDYING THE IMPORTANCE AND NEED OF MOTION CUES IN FLIGHT SIMULATORS UNDER CONTRACT. IN PREVIOUS WORK, A PILOT MODEL WAS DEVELOPED WHICH DEMONSTRATES THE IMPORTANT INTERACTION BETWEEN HANDLING QUALITIES AND MOTION CUE EFFECTS (VISUAL AND MOTION FEEDBACK). WE PLAN TO EXTEND THIS IMPORTANT WORK IN HOUSE TO THE MORE SOPHISTICATE CASE INVOLVING CONTROL OF A SIMULATED VTOL VEHICLE. WE ALSO HOPE TO OBTAIN EYE SCAN MEASURES IN BOTH STUDIES TO DETERMINE THE EFFECTIVENESS OF THIS OBJECTIVE MEASURE FOR EVALUATING THE VARIOUS DISPLAY OR MOTION CONFIGURATIONS TO BE CONSIDERED IN THESE PILOTED SIMULATOR PROGRAMS. THIS RTOP ALSO COVERS MODIFICATION AND MAINTENANCE OF FLIGHT SIMULATION FACILITIES.

RTOP NO. 127-06-17 TITLE: BIONICS  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: LEAVITT, W. Z. TEL. 617-494-2417  
TECHNICAL SUMMARY

TO PROVIDE A BASE FOR THE DEVELOPMENT OF ADVANCED BIOMEASUREMENT INSTRUMENTATION RESEARCH AND STUDY OF MECHANICAL, ELECTRICAL OPTICAL FLUID AND OTHER ANALOG OF HUMAN PHYSIOLOGICAL SYSTEMS WILL BE INVESTIGATED. INITIALLY, A FACILITY WILL BE ESTABLISHED FOR THE PURPOSE OF STUDYING DIGITAL IMAGING PROCESSING WITH THE EMPHASIS IN DEVELOPING TECHNIQUES AND INSTRUMENTATION FOR PERFORMING AUTOMATIC ANALYSIS OF SIGNIFICANT BIOMEDICAL DATA WITH A MINIMUM OF OPERATOR INTERVENTION. MAJOR EQUIPMENT PURCHASES HAVE BEEN INITIATED FOR THE

## ASSEMBLAGE OF THE SYSTEM.

RTOP NO. 127-49-16 TITLE: EFFECTS OF SPACE ENVIRONMENT ON BODY SYSTEMS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-1111

### TECHNICAL SUMMARY

MAJOR RESEARCH EMPHASIS IS PLACED ON THE DEVELOPMENT AND REFINEMENT OF EXISTING METHODS OF QUANTITATING THE EFFECTS OF VARIOUS SPACE ENVIRONMENTS SUCH AS WEIGHTLESSNESS, HYPERGRAVITY, CONFINEMENT, RADIATION AND NUTRITIONAL FACTORS, ON BODY SYSTEMS. STUDIES ARE CONDUCTED TO EVALUATE FACTORS INFLUENCING MUSCLE FUNCTION, BONE METABOLISM, ENERGY UTILIZATION, FOOD AND WATER BALANCE, NEUROENDOCRINOLOGIC STRESS INDICES, DISORIENTATION AND HEAVY PARTICLE EFFECTS ON THE BRAIN. THE APPROACHES TAKEN TO ACQUIRE THIS NECESSARY RESEARCH DATA ARE BY SUBJECTING ANIMALS TO VARIOUS EXPERIMENTAL SITUATIONS, E.G., BONE METABOLISM - LOADING MONKEY LIMBS AND MEASURING CALCIUM DEPOSITION; MUSCLE FUNCTION - THE EFFECTS OF DRUGS ON MUSCULAR CONTRACTION; ENERGY UTILIZATION-MEASUREMENTS (METABOLISM) UNDER ALTERED GRAVITY; FOOD AND WATER BALANCE - MEASURED UNDER ALTERED GRAVITY AND WITH SPECIAL DIETS, AND UNDER HYPOTHERMIC CONDITIONS; STRESS INDICES - BIOASSAY OF HORMONES IN BLOOD AND TISSUES OF ANIMALS SUBJECTED TO STRESS; DISORIENTATION - MEASUREMENT AND COMPUTER ANALYSIS OF VESTIBULARNERVE FIBER RECORDINGS UNDER NORMAL AND ALTERED GRAVITY CONDITIONS; RADIOLOGICAL EFFECTS - EXAMINATION OF RADIATION DAMAGE TO THE BRAIN USING NEUROPATHOLOGIC PROCEDURES. TO ENABLE THE LIMITS OF MAN'S PERFORMANCE TO BE CLOSELY DETERMINED KNOWLEDGE OF THE ABOVE PHYSIOLOGICAL FACTORS ARE NECESSARY SO WE MAY OPERATE AS FAR FROM THE NORMAL PHYSIOLOGICAL TOLERANCES AS POSSIBLE.

RTOP NO. 127-49-17 TITLE: CARDIOVASCULAR PROBLEMS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-1111

### TECHNICAL SUMMARY

TO DEVELOP AND TEST TECHNIQUES FOR DETERMINATION OF CARDIOVASCULAR ADAPTATION TO VARIOUS ENVIRONMENTAL AND PHYSIOLOGICAL STRESSES. STRESSES OF INITIAL IMPORTANCE ARE THOSE OF ACCELERATION, WEIGHTLESSNESS AND EXERCISE. PARTICULAR EMPHASIS WILL BE PLACED ON THESE METHODS SUITABLE FOR USE DURING SPACE FLIGHT TO DETERMINE CARDIOVASCULAR REACTIONS TO REENTRY ACCELERATIONS FOLLOWING AND DURING PROLONGED WEIGHTLESSNESS. MEASUREMENTS OF CARDIOVASCULAR PARAMETERS ARE PLANNED ON HUMAN AND LOWER ANIMALS IN A RESEARCH SPACE STATION (DOGS, BABOONS AND CHIMPANZEES). EMPHASIS IS ALSO PLACED ON THOSE STUDIES WHICH DETERMINE THE NEUROCHEMICAL EFFECTORS WHICH PRODUCE OBSERVED CARDIOVASCULAR CHANGES AND PHARMACOLOGIC OR OTHER MEANS OF MODIFYING SUCH RESPONSES. THESE MEASUREMENTS WILL BE USED TO CREATE BIOCYBERNETIC MODELS OF THE HEART AND CIRCULATION IN ORDER TO IDENTIFY THE ROLE OF VARIOUS CONTROL MECHANISMS AND THE INTERACTION OF MULTIPLE STRESSES ON CARDIOVASCULAR FUNCTION AND TO

PREDICT POSSIBLE MECHANISMS OF CARDIOVASCULAR FAILURE PRIOR TO OR UPON REENTRY FROM ORBITAL FLIGHT. THE USE OF COMPUTER BASED MODELS TO DESCRIBE CARDIOVASCULAR FUNCTION PROVIDES EXACT INFORMATION AS TO WHICH VARIABLES SHOULD BE MEASURED DURING FLIGHT AND ALLOWS FOR FLIGHT SIMULATION OR EXTRAPOLATION OF DATA TO PREDICT THE EFFECTS OF LONG TERM FLIGHT (1 TO 2 YEARS) AT A SIGNIFICANT SAVING IN FUNDS AND PERSONNEL WHEN COMPARED TO THE COSTS FOR ACTUAL MEASUREMENTS DURING FLIGHT OR FOR GROUND-BASED SIMULATIONS OF WEIGHTLESSNESS.

RTOP NO. 127-49-17 TITLE: CARDIOVASCULAR DYNAMICS  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: JOHNSON, R. L. TEL. 713-483-5554  
TECHNICAL SUMMARY

THE CONDITIONS OF SPACEFLIGHT RESULT IN DECREMENTS OF CARDIOVASCULAR PERFORMANCE SIMILAR TO THOSE OBSERVED ON EARTH AFTER HYPODYNAMIC SITUATIONS SUCH AS BED REST OR WATER IMMERSION. UNDERSTANDING OF THE MECHANISMS INVOLVED IN THE IMPAIRED ORTHOSTATIC TOLERANCE AND PHYSICAL CAPACITY ARE PRIME REQUIREMENTS FOR EXTENDING THE DURATION OF MANNED SPACEFLIGHT. TO ACHIEVE THIS UNDERSTANDING FURTHER STUDIES ARE NEEDED OF BASIC PHYSIOLOGY OF THE MYOCARDIUM AND BLOOD VESSELS, MECHANISMS WHICH CONTROL THEIR REACTIONS AND CHANGES BROUGHT ABOUT BY EARTH SIMULATIONS OF SPACE FLIGHT AND BY ACTUAL SPACE FLIGHT. INVESTIGATION OF NON-INVASIVE TECHNIQUES OF CARDIOVASCULAR ASSESSMENT WILL BE CONTINUED AND VALIDATED FOR THEIR APPLICABILITY IN THE SPACEFLIGHT ENVIRONMENT, AIMING FOR INFLIGHT EVALUATIONS TO DETERMINE THE TIME-COURSE AND EXTENT OF CARDIOVASCULAR DECONDITIONING.

RTOP NO. 127-49-18 TITLE: SPACECRAFT ATMOSPHERE EFFECTS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: KLEIN, H. P. TEL. 415-961-1111  
TECHNICAL SUMMARY

MAJOR BIOMEDICAL PROBLEMS IN SPACECRAFT ATMOSPHERES ARE THE CHOICE OF GAS MIXTURE AND PRESSURE, THE EFFECT ON MICROFLORA, AND THE BUILD-UP OF CONTAMINANTS. THE PROBLEM OF GAS MIXTURE AND PRESSURE IS BEING APPROACHED FROM A NUMBER OF ANGLES: (1) BODILY RESPONSE TISSUE CHANGES, AND HEMATOLOGIC AND HEMODYNAMIC CHANGES ARE BEING STUDIED IN MAN AND ANIMALS EXPOSED TO OXYGEN ATMOSPHERES AT VARIOUS PRESSURES AND TO OXYGEN-INERT GAS MIXTURES; (2) THE EXACT PATHOGENESIS OF OXYGEN TOXICITY AS WELL AS THE BASIC BIOPHYSICAL MECHANISM OF OXYGEN DAMAGE IS BEING DETERMINED; (3) PULMONARY AND CARDIOPULMONARY FUNCTION AND RESPIRATORY CONTROL IS BEING STUDIED IN NORMAL AND ABNORMAL ENVIRONMENTS AND UNDER STRESS SUCH AS ALTERED GRAVITY AND VIBRATION; (4) THE EFFECTS OF DECOMPRESSION IN RELATION TO INERT GAS MIXTURES IS BEING INVESTIGATED; AND (5) POSSIBLE METHODS OF PROTECTION TO NOXIOUS ATMOSPHERES ARE ALSO UNDER CONSIDERATION. THE EFFECT OF SPACECRAFT ENVIRONMENTS MICROFLORA CONSISTS OF STUDIES ON UNDERSTANDING OF SPACECRAFT ENVIRONMENTS ON MODIFICATION OF THE EQUILIBRIUM BETWEEN MAN AND MICROORGANISM, ON SYSTEMATIC IDENTIFICATION OF MAN'S MICROORGANISMS AS A REFERENCE SOURCE, AND ON



THE INFLUENCE OF SPACECRAFT ENVIRONMENT ON NATURAL AND ARTIFICIAL FACTORS ASSOCIATED WITH MAN'S ABILITY TO HANDLE INFECTIOUS DISEASE CURRENT WORK INCLUDES THE STUDY OF THE EFFECT OF SIMULATED CABIN ATMOSPHERES ON VIRULENCE AND IMMUNITY, EARLY DIAGNOSIS OF INFECTIOUS DISEASES, AND DIRECTED CONTROL OF INDIGENOUS FLORA AND MICROBIAL ECOLOGY OF A CLOSED SYSTEM. THE EFFECT OF CHEMICAL AND PARTICULATE CONTAMINANTS IN SPACECRAFT ATMOSPHERES IS BEING STUDIED.

RTOP NO. 127-49-19 TITLE: STRESS QUALIFICATIONS (ENDOCRINE PHYSIOLOGY)

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: LEACH, C. S. TEL. 713-483-5281

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO DEVELOP AND ADAPT IMMUNOLOGIC TECHNIQUES TO ENDOCRINOLOGICAL ASSAYS. THIS EFFORT WILL BE SPECIFICALLY DIRECTED TOWARD REDUCING THE BIOLOGICAL SAMPLE SIZE AND INCREASING THE SENSITIVITY AND REPRODUCIBILITY OF SPECIFIC ENDOCRINE ASSAYS. RADIOIMMUNOASSAYS WILL BE DEVELOPED FOR USE WITH SERUM AND WHOLE BLOOD. THESE PROCEDURES WILL COMBINE THE SENSITIVITY PROVIDED BY RADIOISOTOPE METHODOLOGY WITH THE SPECIFICITY OF THE ANTIGENANTIBODY REACTION. THE FUNDAMENTAL PRINCIPAL OF IMMUNOLOGIC ASSAYS WITH RESPECT TO ENDOCRINE CONSTITUENTS IS WELL PROVEN. IT REMAINS, HOWEVER, TO DEVELOP SPECIFIC METHODOLOGIES AND TECHNIQUES ESSENTIAL FOR "IN FLIGHT" USE.

RTOP NO. 127-49-20 TITLE: BIOINSTRUMENTATION

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: ARMSTRONG, G. G. TEL. 713-483-0000

TECHNICAL SUMMARY

THERE IS A GAP WITHIN THE NASA BETWEEN THE VERY EARLY AND BASIC RESEARCH AND THE ACTUAL APPLICATION OF THIS EFFORT TO FLIGHT MISSIONS. THE AREA OF BIOMEDICAL TECHNOLOGY AND IN PARTICULAR, BIOINSTRUMENTATION IS ONE OF THE NOTABLE EXAMPLES OF THIS GAP. ADVANCED TECHNIQUES, METHODOLOGIES, AND INSTRUMENTATION HAVE BEEN CONCEIVED AND PLACED INTO LABORATORY AND RESEARCH ACTIVITIES AT CENTERS SUCH AS ERC, AMES, AND LANGLEY. YET AVAILABLE SPACE QUALIFIED SYSTEMS ARE AT LEAST SIX YEARS BEHIND THE STATE-OF-THE-ART.

FIVE SPECIFIC BIOMEDICAL TECHNOLOGY AREAS ARE BEING EXAMINED: 1) THE MEASUREMENT OF TOTAL BODY VOLUME, 2) EVALUATION OF CARDIAC ARRHYTHMIAS, 3) MEASUREMENT OF INTERMEDIARY METABOLIC ACTIVITIES BY ALVEOLAR GAS ANALYSIS 4) REMOTE BIOELECTRICAL POTENTIAL SENSING AND 5) DEVELOPMENT OF BIOMEDICAL DATA COMPRESSING AND ANALYSIS METHODS. EACH OF THESE AREAS HAVE BEEN DEMONSTRATED AS POTENTIALLY VALUABLE BIOMEDICAL TECHNIQUES BY OTHER NASA CENTERS OR BY THE INDUSTRIAL AND ACADEMIC COMMUNITIES, YET THE CARRYING OF THESE INTO THE PROTOTYPE SYSTEM STAGE HAS NOT YET BEEN INITIATE----

RTOP NO. 127-49-20 TITLE: MEASUREMENT OF HUMAN STRESS AND  
PERFORMANCE (FLIGHT BIOINSTRUMENTATION)

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: LEWIS, C. E., JR. TEL. 805-258-3311

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PLAN IS TO DEVELOP AND FLIGHT QUALIFY ADVANCED BIOINSTRUMENTATION FOR USE IN A HIGH STRESS, DYNAMIC FLIGHT ENVIRONMENT. THIS MAY ONLY BE ACCOMPLISHED THROUGH A SPECIAL AWARENESS OF THE PARTICULAR PROBLEMS INVOLVED IN THE DYNAMIC FLIGHT ENVIRONMENT. APPLICATIONS WILL INCLUDE COLLECTION OF BIODATA FROM PILOTS IN THE HIGH STRESS FLIGHT ENVIRONMENT AND ALSO PERSONNEL OPERATING IN A DYNAMIC ENVIRONMENT. THE APPROACH IS TO DEVELOP SENSORS, SIGNAL CONDITIONING ELECTRONICS, AND PROCESSING EQUIPMENT AND TECHNIQUES TO FURTHER THE UNDERSTANDING OF PHYSIOLOGICAL RESPONSE TO STRESS.

RTOP NO. 127-49-20 TITLE: BIOINSTRUMENTATION

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

TECHNICAL SUMMARY

INSTRUMENTATION IS BEING DEVELOPED FOR MEASUREMENT OF PHYSIOLOGICAL PARAMETERS ON HUMANS AND ANIMALS. A CAPABILITY ALREADY EXISTS FOR IMPLANTING SENSORS IN UNRESTRAINED ANIMALS AND TELEMETERING CERTAIN DATA TO RECEIVERS AND REPORTERS. THIS CAPABILITY WILL BE EXTENDED TO OTHER MORE COMPLEX MEASUREMENTS, MULTIPLE CHANNELS, AND TO OPERATE FROM SMALLER PACKAGES AND FOR LONGER PERIODS OF TIME. NEW SENSING TECHNIQUES WILL BE STUDIED FOR MEASUREMENT OF THE SIZE OF PARTICULAR ORGANS, FLOW VELOCITIES OF BLOOD AND OTHER BODY FLUIDS, NERVE IMPULSE PHENOMENA, AND OTHER FACTORS IMPORTANT IN RESEARCH IN BIOLOGY. A CLOSE WORKING RELATION HAS BEEN ESTABLISHED WITH BIOLOGISTS AT AMES SO THAT INSTRUMENTATION CAN BE DESIGNED AND ADAPTED TO SPECIFIC RESEARCH PROGRAMS AS NEW TECHNIQUES ARE DEVELOPED.

RTOP NO. 127-49-20 TITLE:

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: LEAVITT, W. Z. TEL. 617-494-2417

TECHNICAL SUMMARY

A STUDY AND DEVELOPMENT OF TECHNIQUES FOR MONITORING THE STATUS OF MAN DURING HIGH STRESS AND EXTENDED SPACE FLIGHT IS BEING UNDERTAKEN WITH THE BASIC CONSTRAINTS OF PERFORMING THE MEASUREMENTS IN REAL TIME WITH MINIMUM ENCUMBRANCE TO PERSONNEL AND BY NONINVASIVE TECHNIQUES. BOTH THE PHYSIOLOGICAL AND PSYCHOPHYSIOLOGICAL CONDITION OF MAN ARE UNDER INVESTIGATION WITH PARTICULAR EMPHASIS ON MENTAL ALERTNESS AND THE CARDIOVASCULAR SYSTEM. THE CARDIOVASCULAR INVESTIGATION INVOLVES THE DETERMINATION OF SIGNIFICANT MEASUREMENT PARAMETERS AND THE DEVELOPMENT OF SENSORS FOR NONINVASIVE USE WITH THE MAJOR THRUST TOWARD ULTRASONIC TRANSDUCERS FOR MEASUREMENT OF BLOOD FLOW AND VOLUME. INSTRUMENT DEVELOPMENT SUCH AS AN OXIMETER SUPPORTS THE PROGRAM. MENTAL ALERTNESS IS BEING ATTACKED THROUGH THE

EVALUATION OF EEG SLEEP PATTERNS, PERCEPTUAL AND EVOKED RESPONSES TO AUDITORY AND VISUAL STIMULI. TO PROCESS THE SENSOR OUTPUT ON A REAL-TIME BASIS, A SYSTEM IS BEING ASSEMBLED AND WORK IS CONTINUING IN THE MATHEMATICAL THEORY INCLUDING FILTER AND PATTERN CLASSIFICATION THEORY. ADVANCED BIOTELEMETRY SYSTEMS ARE UNDER INVESTIGATION FOR DATA TRANSMISSION.

RTOP NO. 127-49-21 TITLE: SPACE RADIATION PROTECTION  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: NELSON, C. H. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE HAZARDOUS EFFECTS OF IONIZING SPACE RADIATION ON MAN, PLACES CONSTRAINTS ON MISSION AND SPACECRAFT DESIGNS. RESEARCH IS THEREFORE NECESSARY TO DETERMINE BOTH THE IMMEDIATE AND LONG-TERM RISKS WHEN EXPOSED TO THE RADIATION ENVIRONMENT AND TO ASSESS WHAT DOSE TOLERANCE LEVEL THE BODY AND ITS ORGANS MAY BE ALLOWED. EXPERIMENTAL AND THEORETICAL WORK IS PLANNED TO ANSWER SOME OF THE MORE CRITICAL PROBLEMS, PROTON DAMAGE TO THE EYE, EFFECTS OF PENETRATING ELECTRONS ON SKIN, DISTRIBUTIONS OF SHORT, HEAVY RECOILS IN BEAMS OF HIGH-ENERGY PROTONS, SYNERGISTIC EFFECTS OF RADIATION AND OTHER STRESSES, AND ENERGY DISTRIBUTION IN SMALL VOLUMES. THE RADIOBIOLOGY RESEARCH IS BEING SUPPORTED WITH DEVELOPMENT OF DOSE MEASUREMENT AND MICROBEAM TECHNIQUES FOR APPLICATION TO THE SPACE RADIATION EFFECTS LABORATORY.

RTOP NO. 127-49-22 TITLE: MANNED SPACEFLIGHT MICROBIOLOGICAL PROBLEMS  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: MCQUEEN, J. L. TEL. 713-483-2031  
TECHNICAL SUMMARY

THE OBJECTIVE OF THE MICROBIOLOGY PROGRAM IS TO ENSURE THAT MAN-MICROBE INTERRELATIONSHIPS OCCURRING IN SPACECRAFT ECOSYSTEMS ARE COMPATIBLE WITH MAN'S HEALTH AND SURVIVAL DURING MISSIONS OF EXTENDED DURATION. THIS REQUIRES THE ELUCIDATION AND CONTROL OF POTENTIAL PROBLEMS PECULIAR TO CLOSED ECOLOGICAL SYSTEMS OF SPACECRAFT OR SHELTER ENVIRONMENTS. THE APPROACH WILL BE ONE OF MICROBIAL DETERMINING, USING LAND-BASED SIMULATORS, THE NATURE AND EXTENT OF MICROBIAL INSULT OCCURRING IN MAN AND EXPERIMENTAL ANIMAL MODELS. THE SYSTEMATIC ACCUMULATION OF BIOLOGICALLY PREDICTABLE, COMPARATIVE MEDICAL REFERENCE DATA ON MICROBIAL INTERACTION AND HOST RESPONSE OVER DEFINED TIME INTERVALS WILL RESULT IN A DEFINITION OF DETERMINANTS OF DISEASE AND LEAD ULTIMATELY TO PREVENTION AND/OR CONTROL OF PREVENTIVE MEDICAL PROBLEMS PECULIAR TO SPACECRAFT ENVIRONMENTS.

RTOP NO. 127-49-23 TITLE: PHYSIOLOGICAL TOLERANCE IN AVIATION  
OPERATIONS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-1111

TECHNICAL SUMMARY

TO DEVELOP TECHNIQUES FOR PREDICTION OF IMPACT LOADS AND ASSOCIATED PHYSIOLOGICAL FAILURE SUCH AS IMPOSED BY MILITARY EJECTION SEATS. DATA ON VERTEBRAL FAILURE FROM IMPACT WILL BE OBTAINED FROM ISOLATED VERTEBRA, WHOLE CADAVERS AS WELL AS SPINAL MOCKUPS. THIS INFORMATION WILL YIELD DYNAMIC STRESS-STRAIN CHARACTERISTICS AS A FUNCTION OF THE APPLIED STRAIN RATE. A MATHEMATICAL MODEL OF THE VERTEBRAL COLUMN UTILIZING THIS DATA WILL BE DEVELOPED FOR PREDICTING STRESS LEVELS AND POSSIBLE FRACTURES IN INDIVIDUAL VERTEBRA. TO QUANTITATE IN MAN SYMPTOMS OF DESYNCHRONOSIS OCCURRING WITH PROLONGED RAPID FLIGHT. TO USE THIS INFORMATION AS AN APPROACH TO REDUCING MORBIDITY RATE RESULTING FROM JET AND SST FLIGHTS OF PILOTS, MILITARY AND CIVILIAN PERSONNEL AND POSSIBLY ASTRONAUTS. TO CONCENTRATE ON BASIC MEDICAL PARAMETERS TO DETERMINE THE EXTENT AND DURATION OF DESYNCHRONOSIS AS A LEAD TO PRECAUTIONARY AND CORRECTIVE MEASURES. GROUPS OF 8 SUBJECTS WILL BE MONITORED BEFORE (19 DAYS), DURING (13-18 HOURS), AND AFTER (10 DAYS) FLIGHTS. CENTRAL AND PERIPHERAL NERVOUS SYSTEM ACTIVITY WILL BE ASSESSED. EKG AND BODY TEMPERATURE WILL BE MONITORED CONTINUOUSLY. EMPHASIS WILL BE PLACED ON THE RATES OF CHANGE OF THE BT AND EKG RHYTHMS. PLASMA AMINO ACID PROFILES WILL BE ESTIMATED. THE RESULTS WILL BE CORRELATED WITH MEASUREMENTS OF CHANGES IN METABOLIC FUNCTION IN GENERAL AND ENDOCRINES.

RTOP NO. 127-49-24 TITLE: HUMAN RESPONSE TO ARTIFICIAL GRAVITY

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

EXPERIMENTAL STUDIES WILL BE CONDUCTED TO DETERMINE THE PERFORMANCE CAPABILITIES OF MAN IN A ROTATING ENVIRONMENT AND TO DETERMINE THE EFFECTS OF REDUCED GRAVITY ON THE HUMAN PHYSIOLOGICAL SYSTEM. THE RESULTS WILL BE APPLICABLE TO THE DESIGN OF FUTURE SPACE VEHICLES, SUCH AS SPACE STATIONS, WHERE ROTATION WILL PROVIDE AN ARTIFICIAL GRAVITY ENVIRONMENT. THESE STUDIES WILL BE PERFORMED USING HUMAN SUBJECTS AND GROUND-BASED ROTATING SPACE VEHICLE SIMULATORS TO MEASURE THE SUBJECT'S PHYSIOLOGICAL AND PSYCHOLOGICAL RESPONSE TO THE ENVIRONMENT. RESULTS OF GROUND-BASED RESEARCH MAY INDICATE THE NECESSITY OF PERFORMING SPACE FLIGHT EXPERIMENTS TO COMPLETELY VERIFY MAN'S COMPATIBILITY WITH A ROTATING ENVIRONMENT.

RTOP NO. 127-49-25 TITLE: PSYCHOACOUSTIC ASPECTS OF AIRCRAFT NOISE  
AND SONIC BOOM

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO FURTHER THE UNDERSTANDING OF PSYCHOLOGICAL AND PHYSIOLOGICAL EFFECTS OF NOISE, TO ESTABLISH

TECHNIQUES FOR MEASURING SUBJECTIVE NOISE FACTORS, AND TO APPLY PSYCHOACOUSTIC INFORMATION TO MINIMIZE DETRIMENTAL OR ANNOYANCE EFFECTS ON NOISE IN A NOISE/VIBRATION ENVIRONMENT. STUDIES WILL INCLUDE SUBJECTIVE NOISE COMPARISON TESTS, ABSOLUTE JUDGMENT TESTS, SLEEP INTERFERENCE TESTS, AUDITORY AND NONAUDITORY TESTS, STARTLE TESTS, TASK PERFORMANCE TESTS, AND EAR DAMAGE TESTS. THE TESTS WILL BE ACCOMPLISHED IN LABORATORIES AND UNDER REAL LIFE CONDITIONS OF EXPOSURE TO NOISE OF AIRCRAFT FLIGHT. THE TESTS WILL BE COMPLEMENTED BY SURVEY STUDIES (INVOLVING SOCIAL, ECONOMIC, AND ATTITUDINAL FACTORS) AND BY SPECIAL ANALYTICAL PROGRAMS. THE INFORMATION OBTAINED WILL BE USED IN THE PREDICTION OF PUBLIC REACTIONS TO FUTURE AIRCRAFT/AIRPORT OPERATIONS AND WILL BE APPLIED TO REDUCE NOISE GENERATED BY AIRCRAFT AND TO ALLEVIATE NOISE/VIBRATION EXPOSURES OF PEOPLE.

RTOP NO. 127-49-26 TITLE: CLINICAL SPACE MEDICINE AND PHARMACOLOGY  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: JERNIGAN, C. A. TEL. 713-483-4021  
TECHNICAL SUMMARY

THIS RESEARCH IS DESIGNED TO DEFINE DIAGNOSTIC AND THERAPEUTIC METHODS, PROCEDURES, MEDICATIONS AND EQUIPMENT TO BE USED ON LONG-TERM MANNED MISSIONS TO INSURE THE HEALTH AND WELL-BEING OF FLIGHT CREWS AND TO DETERMINE THE EFFECT OF THE SPACE FLIGHT ENVIRONMENT ON THE METABOLISM AND THERAPEUTIC EFFECTIVENESS OF DRUGS USED SINGULARLY IN COMBINATION. DETAILED EPIDEMIOLOGICAL STUDIES OF THE ASTRONAUT POPULATION ITSELF AND OF HIGHLY SELECTED ANALOGOUS POPULATIONS MUST BE CONDUCTED TO ALLOW BETTER RELIABILITY IN THE PREDICTION OF SPONTANEOUSLY OCCURRING MEDICAL AND DENTAL PROBLEMS. THESE STUDIES SHOULD INCLUDE DATA OBTAINED UNDER CLOSED ECOLOGICAL CONDITIONS. MEDICAL PROCEDURES, CLINICAL EQUIPMENT AND PHYSICIAN-ASTRONAUT TRAINING REQUIREMENTS MUST BE STUDIED AND DEVELOPED TO MAKE INFLIGHT MEDICAL CARE BOTH POSSIBLE AND EFFECTIVE. ONLINE ANALYSIS AND DISPLAYS OF IMPORTANT PARAMETERS SHOULD ALSO BE EMPHASIZED ALONG WITH SEMIAUTOMATED DIAGNOSTIC TECHNIQUES. IN ADDITION, CERTAIN ANIMAL STUDIES WILL UNDOUBTEDLY BE REQUIRED FOR BOTH GROUND-BASED AND INFLIGHT VERIFICATION OF CERTAIN THERAPEUTIC PROCEDURES.

RTOP NO. 127-49-28 TITLE: MEDICAL INVESTIGATIONS IN SPACE SIMULATED ENVIRONMENTS (CHAMBER SIMULATION)  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: MCQUEEN, J. L. TEL. 713-483-2031  
TECHNICAL SUMMARY

EXPERIMENTAL STUDIES WILL BE PERFORMED TO PROVIDE BIOLOGICALLY PREDICTABLE AND STATISTICALLY SIGNIFICANT REFERENCE DATA FOR MAN IN A SPACE-SIMULATED CLOSED ECOLOGICAL ENVIRONMENT. CRITICAL QUESTIONS TO BE ANSWERED DEAL WITH THE CHANGES WHICH OCCUR AS NORMAL ECOLOGIES REVERT TO SPACECRAFT ECOSYSTEMS AND THE CONCOMITANT EFFECTS ON MAN RESULTING FROM ALTERED MICROBIAL PATHOGENICITY AND POSSIBLE CHANGES IN MAN'S IMMUNE RESPONSE MECHANISMS. THESE STUDIES WILL BE PERFORMED

USING HUMAN AND ANIMAL TEST SUBJECTS IN GROUND BASED HERMETIC CHAMBERS. RESULTS OF THESE STUDIES WILL FIND APPLICATION IN THE DESIGN OF FUTURE SPACE VEHICLES, IN DETERMINING NUTRITIONAL REQUIREMENTS FOR MAN AND WILL PROVIDE THE DATA REQUIRED FOR DEFINITION AND ULTIMATE SOLUTION OF PREVENTIVE MEDICAL PROBLEMS EXPECTED TO OCCUR DURING MISSIONS OF EXTENDED DURATION.

RTOP NO. 127-49-30 TITLE: FOOD TECHNOLOGY  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: SMITH, M. C. TEL. 713-483-5056  
TECHNICAL SUMMARY

MISSION DURATIONS, OBJECTIVES, CREW SIZE, VEHICLES, RESUPPLY CAPABILITY, LOCATION, AND OTHER VARIABLES DETERMINE THE ULTIMATE DESIGN OF THE FOOD SYSTEM AND PHYSIOLOGICAL REQUIREMENTS OF THE INDIVIDUALS PARTICIPATING AS PASSENGER, OBSERVER, OR CREW. THIS PROGRAM WILL DETERMINE THE PHYSICAL CHEMICAL, METABOLIC, AND FUNCTIONAL CHARACTERISTICS OF FOODS AND FOOD MANAGEMENT SYSTEMS FOR ADVANCED MANNED SPACECRAFT. THESE DATA WILL BE COMPREHENSIVE AND APPROPRIATE FOR USE BY BIOLOGISTS OR ENGINEERS IN THE DETERMINATION OF THE OPTIMAL COMBINATION OF NUTRIENTS, PACKAGES, AND FACILITIES FOR SPECIFIC MISSIONS. THESE DATA WILL ALSO BE EXTRAPOLATED TO SOLVE PROBLEMS IN NUTRITION, FOOD MANUFACTURE, PRESERVATION, AND DISTRIBUTION IN EARTH SITUATIONS.

RTOP No. 127-49-31 TITLE: HEMATOLOGY, IMMUNOLOGY, AND BIOCHEMISTRY  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: FISHER, C. L. TEL. 713-483-5981  
TECHNICAL SUMMARY

EXTENSIVE BIOCHEMICAL INVESTIGATIONS PERFORMED ON SELECTED GEMINI FLIGHTS AND CHAMBER STUDIES, AND IN SUPPORT OF APOLLO MISSIONS, INDICATE A DETRIMENTAL EFFECT OF OXYGEN ON THE FORMED ELEMENTS OF THE BLOOD AND ON HEMOSTATIC MECHANISMS. THE FOLLOWING RESEARCH PROGRAMS ARE BEING CONDUCTED TO ELUCIDATE THE MECHANISMS OF THIS TOXIC EFFECT OF HIGH OXYGEN PRESSURES AND TO ASSESS THE APPARENT MODERATING EFFECT OF DILUENT GASES. 1. ASSESSMENT OF RED CELL PHYSIOLOGY AND STRUCTURE WITH REGARD TO THE TOXIC EFFECTS OF OXYGEN. MEASUREMENTS WILL INCLUDE EVALUATION OF RED CELL MEMBRANE STATES, ENZYME KINETICS, AND PHYSICAL-CHEMICAL CHARACTERISTICS OF THE RED CELL POPULATION. 2. RBC AND PLASMA ALPHA TOCOPHEROL AND ITS OXIDATIVE PRODUCTS WILL BE MEASURED USING MASS SPECTROMETRY AND IR ANALYSIS. 3. TECHNIQUES WILL BE DEVELOPED FOR CONTINUOUS AUTOMATIC MEASUREMENT OF INTRAVASCULAR RED CELL DESTRUCTION BY MONITORING ENDOGENOUS CO EXHALATION IN THE BREATH OF ASTRONAUTS IN SPACE. TECHNIQUES ARE BEING DEVELOPED USING WHOLE BLOOD SINGLE RADIAL IMMUNO DIFFUSION, ELECTROIMMUNO DIFFUSION, AND ALLIED METHODOLOGIES TO ASSESS THE IN-FLIGHT CELLULOSES AND HUMERAL IMMUNE REACTIONS IN MAN.



RTOP NO. 127-49-31 TITLE: HEMATOLOGY, IMMUNOLOGY, AND BIOCHEMISTRY  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: FISCHER, C. L. TEL. 713-483-5981  
TECHNICAL SUMMARY

EXTENSIVE BIOCHEMICAL INVESTIGATIONS PERFORMED ON SELECTED GEMINI FLIGHTS AND CHAMBER STUDIES, AND IN SUPPORT OF APOLLO MISSIONS, INDICATE A DETRIMENTAL EFFECT OF OXYGEN ON THE FORMED ELEMENTS OF THE BLOOD AND ON HEMOSTATIC MECHANISMS. THE FOLLOWING RESEARCH PROGRAMS ARE BEING CONDUCTED TO ELUCIDATE THE MECHANISMS OF THIS TOXIC EFFECT OF HIGH OXYGEN PRESSURES AND TO ASSESS THE APPARENT MODERATING EFFECT OF DILUENT GASES. 1. ASSESSMENT OF RED CELL PHYSIOLOGY AND STRUCTURE WITH REGARD TO THE TOXIC EFFECTS OF OXYGEN.

MEASUREMENTS WILL INCLUDE EVALUATION OF RED CELL MEMBRANE STATES, ENZYME KINETICS, AND PHYSICAL-CHEMICAL CHARACTERISTICS OF THE RED CELL POPULATION. 2. RBC AND PLASMA ALPHA TOCOPHEROL AND ITS OXIDATIVE PRODUCTS WILL BE MEASURED USING MASS SPECTROMETRY AND IR ANALYSIS. 3. TECHNIQUES WILL BE DEVELOPED FOR CONTINUOUS AUTOMATIC MEASUREMENT OF INTRAVASCULAR RED CELL DESTRUCTION BY MONITORING ENDOGENOUS CO EXHALATION IN THE BREATH OF ASTRONAUTS IN SPACE. TECHNIQUES ARE BEING DEVELOPED USING WHOLE BLOOD SINGLE RADIAL IMMUNO DIFFUSION, ELECTROIMMUNO DIFFUSION, AND ALLIED METHODOLOGIES TO ACCESS THE IN-FLIGHT CELLULOS AND HUMORAL IMMUNE REACTIONS IN MAN.

RTOP NO. 127-49-32 TITLE: MUSCULOSKELETAL METABOLISM  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: RAMBAUT, P. C., DR. TEL.  
TECHNICAL SUMMARY

THE EFFECTS OF PROLONGED HABITATION OF EXTRATERRESTRIAL VEHICLES, SHELTERS, AND FACILITIES ON MUSCULOSKELETAL FUNCTION AND CHARACTERISTICS WILL BE DETERMINED. THESE EFFECTS WILL BE INVESTIGATED TO DETERMINE THE IMPACT ON THE PERFORMANCE AND HEALTH OF MAN IN HIS NOMINAL EARTH ENVIRONMENT, THE VARIOUS AEROSPACE ENVIRONMENTS, AND COMBINATIONS OF BOTH. DELETERIOUS EFFECTS SHALL BE IDENTIFIED AND METHODS OF CORRECTION THROUGH DIETARY AND ENVIRONMENTAL MANIPULATION SHALL BE DETERMINED IN SIMULATED AEROSPACE SITUATIONS. EQUIPMENT TO MONITOR MUSCULOSKELETAL STATUS AND DETECT TENDENCIES TOWARD METABOLIC IMBALANCE OF A DIETARY NATURE WILL BE DEVELOPED FOR INSTALLATION IN THE SPACECRAFT OR FACILITY.

RTOP NO. 127-49-33 TITLE: RADIOBIOLOGY  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: BARNES, C. M. TEL. 713-483-4251  
TECHNICAL SUMMARY

THIS RESEARCH PROGRAM IS DESIGNED TO EXPLORE AND DEFINE THE POTENTIAL BIOLOGICAL HAZARDS OF THE SPACE RADIATION ENVIRONMENT TO MANNED SPACE MISSION. THE PHYSIOLOGIC AND PATHOLOGIC CHANGES IN MAN SUBJECTED TO LONG DURATION SPACE RADIATION IS CONSIDERED. THE APPROACH USED INCLUDES RETROSPECTIVE STUDIES OF HUMAN RESPONSE TO RADIATION THERAPY AND ACCIDENTAL EXPOSURES TO VARIOUS RADIATION SOURCES. IN ADDITION, EXPERIMENTAL ANIMALS ARE UTILIZED IN STUDIES

SPECIFICALLY DESIGNED TO SIMULATE THE SPACE RADIATION HAZARD. RESULTS ARE EVALUATED AND COMPARED WITH HUMAN RESPONSE TO RADIATION.

RTOP NO. 127-49-34 TITLE: NEUROPHYSIOLOGY  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: DELUCCHI, M. R. TEL. 713-483-4731  
TECHNICAL SUMMARY

IT IS NECESSARY TO INVESTIGATE AND EVALUATE THE EFFECTS OF THE SPACE ENVIRONMENT UPON THE NERVOUS SYSTEM OF MAN. THIS BODY SYSTEM COMMANDS PARTICULAR ATTENTION IN THAT IT CONSTITUTES THE PRIME SENSORY, MOTOR, AND COORDINATING MECHANISM FOR HUMAN PERFORMANCE AND BEHAVIOR. THE FUNCTION OF THIS SYSTEM UNDER ALTERED ENVIRONMENTS IS, THEREFORE, OF MAJOR SIGNIFICANCE IN ANY ATTEMPT TO EITHER EVALUATE OR PREDICT HUMAN CAPABILITIES AND PERFORMANCE. IT IS REQUIRED THAT NERVOUS SYSTEM PHYSIOLOGY BE ASSESSED BOTH UNDER CONDITIONS OF GROUND BASED RESEARCH AND DURING SPACE MISSION SO THAT THE INFORMATION OBTAINED CAN BE UTILIZED TO INSURE APPROPRIATE SAFETY AND PERFORMANCE POTENTIAL. PARTICULAR INTEREST FOCUSES UPON THE FOLLOWING: SPATIAL ORIENTATION UNDER ALTERED GRAVITATIONAL FIELDS, MOTION SICKNESS, VISUAL PERCEPTION, SLEEP/WAKE STATES, BIORHYTHMS AND WORK/REST CYCLES. INCREASED UNDERSTANDING OF THE ROLE OF THE NERVOUS SYSTEM IN THESE AREAS WILL HAVE DIRECT APPLICATION TO SPACECRAFT DESIGNS, SPACE FLIGHT OPERATIONS AND MISSION PLANNING. A COORDINATED PROGRAM OF NEUROPHYSIOLOGICAL STUDY ENCOMPASSING BASELINE STUDIES IN LABORATORIES AND OPERATIONAL SITES, AS WELL AS INFLIGHT DATA COLLECTION WILL BE UNDERTAKEN TO OBTAIN REQUIRED INFORMATION RELATIVE TO MANNED SPACE FLIGHT AND LUNAR.-----

RTOP NO. 127-49-35 TITLE: BEHAVIOR  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: SHUMATE, W. H. TEL. 713-483-4731  
TECHNICAL SUMMARY

INCREASED UNDERSTANDING OF INDIVIDUAL AND SMALL GROUP BEHAVIOR IS REQUIRED TO INSURE OPTIMAL SELECTION, TRAINING, CREW COMPOSITION AND PERFORMANCE OF MISSION GOALS DURING SPACE FLIGHT. CONFINEMENT, STRESS AND FATIGUE ARE PSYCHOPHYSIOLOGICAL FACTORS WELL KNOWN TO INFLUENCE BEHAVIOR. WITH INCREASES IN MISSION DURATION, THE PSYCHOPHYSIOLOGICAL FUNCTION BECOMES INCREASINGLY IMPORTANT. THIS FUNCTION IMPACTS INTERGROUP RELATIONS, COOPERATION, DECISION MAKING AND OVERALL PERFORMANCE CAPABILITY. INVESTIGATION OF PSYCHOLOGICAL AND PHYSIOLOGICAL CORRELATES OF INDIVIDUAL AND SMALL GROUP BEHAVIOR AND PERFORMANCE WILL BE DIRECTED TO OBTAINING INCREASED ASSESSMENT METHODOLOGY AND PREDICTIVE TECHNIQUES REGARDING HUMAN BEHAVIOR.

RTOP NO. 127-49-36 TITLE: THERMAL PHYSIOLOGY  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: WALIGORA, J. M. TEL. 713-483-5156  
TECHNICAL SUMMARY

THE OBJECTIVES OF THE THERMAL PHYSIOLOGY PROGRAM ARE: 1) TO IMPROVE OUR ABILITY TO DESCRIBE THE TEMPERATURE DISTRIBUTION AND THERMOREGULATORY RESPONSES OF MEN AS A FUNCTION OF ANY ENVIRONMENT. 2) TO DEFINE TOLERANCE AND COMFORT LIMITS ON THE BASIS OF BODY TEMPERATURE AND THERMOREGULATORY RESPONSES. 3) TO SELECT AUTOMATIC ENVIRONMENTAL CONTROL SYSTEMS RESPONDING TO CHANGES IN BODY TEMPERATURE AND THERMOREGULATORY RESPONSES.

RTOP NO. 127-51-11 TITLE: HUMAN ENGINEERING AND PERFORMANCE MEASUREMENT

ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: KLEIN, H. P. TEL. 415-961-1111  
TECHNICAL SUMMARY

RESEARCH IS BEING CONDUCTED TO SOLVE CRITICAL PROBLEMS OF THE MAN-MACHINE INTERFACE, WHICH HAVE BEEN IDENTIFIED IN PREVIOUS SPACE FLIGHTS, OR ARE EXPECTED TO OCCUR IN ADVANCED SPACE MISSIONS. SPECIAL ATTENTION IS BEING GIVEN TO ADVANCED (COMPUTER AIDED) PROCEDURES THAT WILL BE REQUIRED TO SOLVE PROBLEMS OF STAFFING AND TRAINING IN THE MSC MISSION CONTROL CENTER. APPLICATIONS WILL BE MADE TO TRAINING OTHER NASA PERSONNEL, INCLUDING SPACE CREWS. TECHNIQUES ARE BEING DEVELOPED TO ASSIST MAN IN MAKING DECISIONS. THESE TECHNIQUES WILL BE APPLIED DURING BOTH THE PLANNING AND EXECUTION PHASES OF SPACE FLIGHT. THEY WILL BE INTEGRATED WITH ASTRONAUT AND GROUND CONTROLLER ACTIVITIES. METHODS FOR ASSESSING THE PERFORMANCE OF INDIVIDUALS AND GROUPS ARE UNDER DEVELOPMENT. THE QUALITY OF INDIVIDUAL PSYCHOLOGICAL ADJUSTMENT, INTERPERSONAL BEHAVIOR, AND TASK-ORIENTED ACTIVITIES ARE BEING CONSIDERED. A BATTERY OF TASK-ORIENTED PERFORMANCE TESTS IS UNDER DEVELOPMENT. TECHNIQUES FOR DEVELOPING EQUIPMENT SUITABLE FOR EXTRAVEHICULAR AND PLANETARY SURFACE OPERATIONS ARE BEING INVESTIGATED. SPECIFIC AREAS ARE THE DEVELOPMENT OF IMPROVED MOBILITY AIDS, TOOLS AND OTHER EQUIPMENT REQUIRED FOR ASTRONAUT OPERATIONS IN EVA AND ON THE LUNAR SURFACE. RESEARCH ON REMOTE MANIPULATORS (TELEOPERATORS) SUITABLE FOR MAINTENANCE AND SCIENTIFIC EXPLORATION TASKS IN SPACE IS ALSO UNDERWAY.

RTOP NO. 127-51-12 TITLE: AIRCREW PERFORMANCE AND STRESS APPRAISAL  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: KLEIN, H. P. TEL. 415-961-1111  
TECHNICAL SUMMARY

RESEARCH IS BEING CONDUCTED TO INVESTIGATE MAN-MACHINE INTERFACE PROBLEMS OF AERONAUTICS. AREAS OF CONCERN ARE: PILOT INFORMATION HANDLING AND DECISION MAKING, PILOT PERFORMANCE AND SENSITIVITY LIMITS (ESPECIALLY VISUAL PERFORMANCE), PILOT PERFORMANCE DURING LOW VISIBILITY LANDING, DISORIENTATION, DETERMINATION OF OPTIMUM CREW COMPOSITION AND TASK ALLOCATION. INVESTIGATIONS ARE BEING CONDUCTED

THROUGH CONTRACTS, GRANTS, AND IN-HOUSE PROGRAMS IN AN EFFORT TO HELP IDENTIFY SIGNIFICANT HUMAN FACTORS PROBLEMS IN AERONAUTICS AND TO ESTABLISH DESIGN PRINCIPLES OR OTHER MEANS TO SOLVE OR MINIMIZE THESE PROBLEMS. THE MAIN THRUST OF THIS EFFORT IS TO INCREASE SAFETY AND EFFICIENCY IN GENERAL AND COMMERCIAL AVIATION OPERATIONS BY OPTIMIZING OPERATIONAL PROCEDURES AND AIRBORNE AND GROUND SUPPORT FUNCTIONS.

RTOP NO. 127-51-13 TITLE: MAN-COMPUTER SYMBIOSIS  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: VAN METER, D. TEL. 617-494-2646  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE TECHNOLOGY AND OPERATIONAL METHODOLOGY FOR MORE EFFECTIVE INTEGRATION OF MAN-COMPUTER SYSTEMS IN FUTURE AEROSPACE MISSIONS. THE FEASIBILITY AND USEFULNESS OF SPEECH AND GRAPHICS AS COMMUNICATION MEDIA BETWEEN MAN AND COMPUTER ARE OF CENTRAL CONCERN. EMPHASIS IS ALSO GIVEN TO THE USE OF COMPUTERS TO ASSIST IN INSTRUCTIONAL TASKS APPROPRIATE TO LONG-DURATION SPACE FLIGHT. A FINAL GOAL IS THE DEVELOPMENT OF COMPUTER AIDS TO HUMAN REASONING AND DECISION MAKING APPLICABLE TO THE COMMAND AND CONTROL PROBLEMS OF MANNED SPACE FLIGHT. THESE EFFORTS INTERACT STRONGLY WITH ON-GOING PROGRAMS OF THE COMPUTER RESEARCH LABORATORY IN HARDWARE AND SOFTWARE RESEARCH, INCLUDING WORK ON INPUT/OUTPUT TECHNIQUES, PROGRAMMING LANGUAGES, RESOURCE ALLOCATION AND TIME-SHARING.

RTOP NO. 127-51-14 TITLE: ADVANCED HUMAN ENGINEERING CONCEPTS  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: LEAVITT, W. Z. TEL. 617-494-2417  
TECHNICAL SUMMARY

OCULOMETRY FOR QUANTITATIVE TRACKING OF PILOT'S EYE MOVEMENT IN AN UNENCUMBERED MANNER IS UNDER FIELD INVESTIGATION TO VALIDATE IT FOR MEETING THE NECESSARY LATERAL, VERTICAL AND ANGULAR COVERAGE FOR DESIGN OF AIRCRAFT COCKPIT CONFIGURATIONS.

RTOP NO. 127-51-15 TITLE: CREW PERFORMANCE AND DATA HANDLING  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: LEWIS, C. E., JR. TEL. 805-258-3311  
TECHNICAL SUMMARY

THIS WORK INVESTIGATES THE RELATIONSHIPS BETWEEN CREW PERFORMANCE AS INDICATED BY PHYSIOLOGICAL RESPONSES TO THE FLIGHT ENVIRONMENT AND INCLUDES THE DATA HANDLING AND REDUCTION TECHNIQUES NECESSARY TO CORRELATE THESE DATA WITH BASELINE PHYSIOLOGICAL INFORMATION.

RTOP NO. 127-51-17 TITLE: AIR CREW AND GROUND SUPPORT CREW  
PERFORMANCE AND STRESS APPRAISAL

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

OBJECTIVE: 1. DETERMINE PILOT INFORMATION REQUIREMENTS AND DYNAMIC PERFORMANCE IN AIRCRAFT SIMULATORS. 2. IDENTIFY AND DEFINE THE HUMAN FACTORS PROBLEMS ASSOCIATED WITH THE OPERATION OF AIR TRAFFIC CONTROL SYSTEMS. 3. SUPPLY QUANTITATIVE NOISE AND VIBRATION CRITERIA ACCEPTABLE FOR CREWS AND PASSENGERS IN V/STOL AIRCRAFT AND IN HIGH-SPEED GROUND TRANSPORTATION. 4. HUMAN FACTORS BASIC VISUAL MOTION SIMULATOR RESEARCH RELATED TO MILITARY AND CIVILIAN AIRCRAFT OPERATIONS PROBLEMS AND TRAINING. 5. THE DMS WILL PERMIT TWO PILOTS TO MANEUVER SEPARATE AND INDEPENDENT SIMULATED VEHICLES WITH RESPECT TO EACH OTHER. FOR THE FIRST TIME, AS A HUMAN FACTORS RESEARCH TOOL, WORK-LOAD, VISION, SOUND, AND MOTION, AND THEIR RELATIONS TO SUCH TASKS AS AIR COMBAT MAY REALISTICALLY BE STUDIED IN A LABORATORY IN GREAT DETAIL. THE HUMAN FACTORS ELEMENT OF THE MAN-MACHINE COMBINATION MUST BE STUDIED IN GREAT DETAIL TO DETERMINE THOSE QUALITIES OF A VEHICLE THAT CAN EFFECTIVELY BE UTILIZED, SO THAT EFFICIENT DESIGN TRADE-OFFS CAN BE MADE DURING THE EARLY DESIGN PHASES OF A VEHICLE. THE HUMAN FACTORS STUDIES WILL ALSO GIVE A BETTER INSIGHT TO THE DESIGN OF FUTURE SIMULATORS, ESPECIALLY THOSE FOR TRAINING PURPOSES. ONCE THE HUMAN FACTORS ELEMENTS OF THE MAN-MACHINE RELATIONSHIP ARE BETTER UNDERSTOOD, THE DESIGN OF A SIMULATOR MAY BE ACCOMPLISHED WITH LESS COST AND STILL WITH EFFECTIVE TRAINING CARRYOVER TO A REAL-LIFE SITUATION. APPROACH: 1. UTILIZING EYE MOTION MEASUREMENT DEVICE DEVELOPED BY ERC, DETERMINE IN SIMULATOR AND AIRCRAFT (AS SUITABLE) DISPLAY AND OUTSIDE CUES UTILIZED BY PILOTS IN VARIOUS TYPES OF AIR OPERATIONS. DETERMINE THE PILOT DYNAMIC CHARACTERISTIC THEREIN. 2. ANALYZE SYSTEMS ACTIVITY TO IDENTIFY AND DEFINE TASKS PERFORMED BY HUMAN AIR TRAFFIC CONTROLLERS AND THEIR EQUIPMENT IN ATC SYSTEMS WORKING CLOSELY WITH NAFEC.-----

RTOP NO. 127-51-18 TITLE: LUNAR MOBILITY AND HABITABILITY STUDIES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3348

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RESEARCH EFFORT ARE TO (1) DEVELOP AN UNDERSTANDING OF THE EFFECT OF REDUCED GRAVITY ON MAN'S WALKING, RUNNING, AND OTHER SELF-LOCOMOTIVE CAPABILITIES AND OBTAIN ENGINEERING DATA PERTINENT TO THESE CAPABILITIES; (2) DEVELOP THE TECHNOLOGY FOR THE DESIGN OF LUNAR SURFACE AND FLYING MOBILITY DEVICES WITH REFERENCE TO MAN'S ABILITY TO OPERATE SUCH DEVICES; (3) DEVELOP THE TECHNOLOGY FOR SIMULATORS APPLICABLE TO LUNAR MOBILITY RESEARCH, DEVELOPMENT AND TRAINING; AND (4) DEVELOP THE TECHNOLOGY FOR EXTENDED-STAY-TIME LUNAR SHELTERS AND THEIR OPERATION. EXPLORATION OF THE MOON WILL REQUIRE THE ASTRONAUTS TO STAY FOR EXTENDED PERIODS OF TIME AND MOVE ABOUT THE LUNAR SURFACE PERFORMING A VARIETY OF TASKS WITH VARIOUS PIECES OF EQUIPMENT WHILE WEARING A PRESSURIZED SPACE SUIT AND LIFE SUPPORT. IN ORDER TO REACH AREAS OF

INTEREST WITHIN MISSION TIME LIMITS, DIFFERENT FORMS OF MOBILITY DEVICES WILL BE REQUIRED. RESEARCH SHOULD BE CONDUCTED USING LUNAR GRAVITY SIMULATION FACILITIES TO OBTAIN ENERGY EXPENDITURE MEASUREMENTS OF THE MAN PERFORMING TYPICAL LUNAR TASKS AND EVALUATE THE HANDLING QUALITIES OF VEHICLES AND DEVICES INTENDED FOR HIS USE. THE LUNAR WALKING-TYPE DATA WILL BE OBTAINED USING REPRESENTATIVE TYPES OF SPACE SUITS FOR VARIOUS SIMULATED CONDITIONS OF LUNAR SOIL, SURFACE SLOPES, LOCOMOTION SPEED AND GAIT, AND EQUIPMENT WEIGHT AND FORM. TECHNOLOGY READINESS DATA FOR THESE DATA APPLIED TO EARLY LUNAR MISSIONS IS MID-1971, AND MID-1973 APPLIED TO MORE ADVANCED MISSIONS. THE MOBILITY DEVICE RESEARCH WILL HELP ESTABLISH THE HUMAN ENGINEERING DESIGN CRITERIA, VERIFY SPECIFIC DESIGN APPROACHES, AND PROVIDE INFORMATION USEFUL IN ESTABLISHING MISSION OPERATIONAL PROCEDURE. TECHNOLOGY READINESS DATE FOR THIS INFORMATION APPLIED TO EARLY LUNAR MISSIONS IS MID-1973, AND IS 1975 APPLIED TO MORE ADVANCED MISSIONS. THE LUNAR GRAVITY SIMULATION TECHNOLOGY DEVELOPED AS PART OF THIS EFFORT WILL BE USEFUL FOR ASTRONAUT TRAINING AS WELL.

UTILIZATION OF LUNAR SHELTERS FOR EXTENDED MISSIONS REQUIRES THE STUDY OF MAN-SHELTER INTERFACES WITH THE OBJECTIVE OF DETERMINING OPTIMUM MAN-SHELTER COMPATABILITY WITH RESPECT TO BOTH PHYSIOLOGICAL AND PSYCHOLOGICAL FACTORS. THE STUDIES WILL EXAMINE THE IMPACT OF LUNAR SHELTER DEPLOYMENT, ACTIVATION, OPERATION, AND CONFINEMENT ON CREW PSYCHOLOGICAL, PHYSIOLOGICAL, AND MOBILITY FUNCTIONS, AND WILL ANALYSE LUNAR SHELTER LIFE SUPPORT SYSTEM REQUIREMENTS INCLUDING THERMAL CONTROL PROBLEMS. (CONTINUED) ----

RTOP NO. 127-51-19 TITLE: ASTRONAUT MOBILITY IN SPACE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

OBJECTIVES: TO DEVELOP THE TECHNOLOGY FOR SMALL POWERED FLYING DEVICES REQUIRED FOR MAN TO MOVE ABOUT OUTSIDE THE SPACE VEHICLE. TO DEVELOP THE TECHNOLOGY FOR UNPOWERED LOCOMOTION AIDS ATTACHED TO THE VEHICLE TO PERMIT MAN TO MOVE ABOUT INSIDE AND OUTSIDE THE SPACE STATION. APPROACH: PERFORM STUDIES REQUIRED TO DEVELOP SIMPLE EFFECTIVE EQUIPMENT FOR THE CONTROL OF ATTITUDE AND TRANSLATION FOR ASTRONAUT MOBILITY DEVICES FOR USE AROUND SPACE STATIONS IN EARTH ORBIT ABOUT 1974-1975. IDENTIFY REQUIREMENTS AND DEVELOP EQUIPMENT NEEDED FOR MAN TO MOVE ABOUT THE VEHICLE TO REACH VARIOUS AREAS ON OUTER SURFACE, SUCH AS ATTACHED EXPERIMENT PODS, AND TO CARRY CARGO SUCH AS FILM CANNISTERS AND TOOLS. CONSIDER USE OF IMPROVED GUIDERAILS, TROLLEYS AND EXTENSIBLE BOOMS.

RTOP NO. 127-51-20 TITLE: SMALL GROUP DYNAMICS AND CREW STRUCTURE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

STUDIES WILL BE PERFORMED TO DETERMINE THE EFFECTS OF ISOLATION, CONFINEMENT, AND OTHER PSYCHOLOGICAL STRESSES ON SMALL GROUP STRUCTURE AND COHESIVENESS. THIS RESEARCH WILL LEAD TO THE



DEVELOPMENT OF A RATIONAL ANALYSIS METHOD OF MAN-MACHINE INTERACTIONS FOR APPLICATION TO SYSTEMS DESIGNS, THE DEVELOPMENT OF SPECIFIC MEASURES AND EQUIPMENT TO OBTAIN DATA FOR MONITORING PERFORMANCE IN CRITICAL ENVIRONMENTS, AND TO THE DEVELOPMENT OF CREW SELECTION CRITERIA FOR SPECIFIC SPACE MISSIONS. IN ADDITION, EFFORTS WILL BE MADE TO FURTHER THE APPLICATION OF COMMUNICATION THEORY TO THE STUDY OF HUMAN SUBSYSTEMS. MAN WILL BE STUDIED AS AN INFORMATION PROCESSING SYSTEM IN A FULLY INSTRUMENTED COCKPIT TO DETERMINE IF PILOT BEHAVIOR IS GOVERNED BY THE INFORMATION - THEORETIC CHARACTERISTICS OF THE PHYSICAL SYSTEM.

RTOP NO. 127-51-23 TITLE: MAN-SYSTEM INTEGRATION  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: JOHNSON, C. C. TEL. 713-483-3491  
TECHNICAL SUMMARY

THE MAN-SYSTEMS INTEGRATION PROGRAM IS DIVIDED INTO TWO MAJOR AREAS OF WORK: 1) HUMAN PERFORMANCE AND EQUIPMENT DESIGN TECHNOLOGY AND 2) HABITABILITY. THE OBJECTIVE OF THE HUMAN PERFORMANCE AND EQUIPMENT DESIGN TECHNOLOGY PROGRAM IS TO DEFINE MAN'S CAPABILITY TO PERFORM USEFUL WORK IN THE SPACE ENVIRONMENT AND TO DETERMINE AND DEVELOP THE PROCEDURES, TECHNOLOGY AND EQUIPMENT NECESSARY TO ASSIST HIM IN PERFORMING THAT WORK. THE THREE AREAS OF INVESTIGATION ARE: 1) HUMAN PERFORMANCE CAPABILITIES AND DESIGN CRITERIA, 2) PROFICIENCY MAINTENANCE, AND 3) OPERATOR AND EQUIPMENT TECHNOLOGY. THE OBJECTIVE OF THE HABITABILITY AREA IS TO DEFINE CRITERIA AND REQUIREMENTS APPROPRIATE TO SPACECRAFT DESIGN. HABITABILITY WILL CONSIST OF MAJOR SUBELEMENTS OF ENVIRONMENT ARCHITECTURE MOBILITY AND RESTRAINT, FOOD SYSTEMS, SHIRT-SLEEVE GARMENTS AND PERSONAL ACCOUTERMENTS, PERSONAL HYGIENE AND HOUSEKEEPING. THIS EFFORT WILL CONSIDER THE SUBELEMENTS AS A SUBSYSTEM FOR WHICH STANDARDS CAN BE DERIVED AND USED AS DESIGN GUIDELINES.

RTOP NO. 127-51-25 TITLE: AERONAUTICS HUMAN FACTORS ENGINEERING  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: MADIGAN, R. J. TEL. 617-494-2026  
TECHNICAL SUMMARY

WITH THE ADVENT OF THE HIGH PERFORMANCE COMMERCIAL JET AIRCRAFT, REQUIREMENTS WERE CREATED FOR SOPHISTICATED AIR-BORNE AND GROUND-BASED ELECTRONIC SYSTEMS AND DISPLAYS WITH ONLY SLIGHT EMPHASIS ON GENERALLY APPLICABLE HUMAN FACTORS RESEARCH KNOWLEDGE. RATHER, THE APPLICATION OF HUMAN FACTORS ENGINEERING FOR COMMERCIAL AERONAUTICS HAS BEEN MORE ORIENTED TOWARD SPECIFIC AIRCRAFT ELECTRONIC SYSTEM INSTALLATIONS UNDER THE SPONSORSHIP OF THE COMMERCIAL INTERESTS SELLING EITHER THE FLIGHT INSTRUMENTATION OR AIRCRAFT. THOUGH THIS APPROACH HAS FULFILLED CERTAIN NEEDS BY DELIVERING OPERATIONAL AIRCRAFT TO THE AIR CARRIER, WE ARE FACED TODAY WITH THE PROBLEM OF ESTABLISHING REQUIREMENTS AND INTERFACES FOR A NEW GENERATION OF EQUIPMENT INVOLVING THE HUMAN OPERATOR. A NEW ERA IS IMMINENT WHICH WILL SEE AN AIR TRANSPORTATION ENVIRONMENT WHICH WILL MIX TODAY'S CONVENTIONAL AIRCRAFT WITH JUMBO JETS,

SUPERSONIC AIRCRAFT AND VERTICAL AND SHORT TAKE-OFF AND LANDING AIRCRAFT. THIS MIXTURE, ESPECIALLY IN THE TERMINAL ENVIRONMENT, ESTABLISHES A CRITICAL NEED FOR EVALUATING THE INTERFACES OF AIRCRAFT/AIRPORT AND AIRCRAFT/AVIATOR. THE GOAL OF HUMAN FACTORS ENGINEERING IN THESE TWO INTERFACE AREAS WILL BE TO HELP ESTABLISH CLEAR-CUT OBJECTIVES FOR EFFECTIVE SYSTEM DESIGNS INVOLVING THE HUMAN OPERATOR. IN PARTICULAR, WORK EFFORTS WILL INVOLVE ESTABLISHING THOSE CRITICAL INFORMATION REQUIREMENTS FOR PILOTING, PILOT MANAGEMENT FOR AUTOMATIC AND SEMI-AUTOMATIC LANDING SYSTEM AND AIRPORT CHARACTERISTICS AS THEY AFFECT PILOT AND CREW ACTIVITIES UNDER VFR AND IFR CONDITIONS. LABORATORY SIMULATION WITH BOTH HARDWARE AND SOFTWARE AND FLIGHT TEST EVALUATIONS WILL BE USED IN THE PROOF-OF-CONCEPTS.

RTOP NO. 127-51-28 TITLE: APPROACH AND LANDING DISPLAYS -  
VISIBILITY ENVELOPE FLIGHT EVALUATION

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: CARPENTER, L. R. TEL. 805-258-3311

TECHNICAL SUMMARY

COCKPIT VISIBILITY EXPERIMENTS ARE REQUIRED INVOLVING LABORATORY AND ACTUAL FLIGHT TEST. THESE STUDIES ARE SPECIFICALLY AIMED AT LIFTING BODIES AND OTHER SHUTTLE CRAFT CONFIGURATION REQUIREMENTS. THE SUBJECTS FOR THESE STUDIES SHALL BE TEST PILOTS WITH X-15 AND LIFTING BODY FLYING EXPERIENCE. EXPERIENCE TO DATE INDICATES THAT FAST APPROACHES IN LIFTING BODIES CAUSE SIDE-VISION BLURRING AND THE LOW HEAD HEIGHTS RELATIVE TO STRUCTURE HAMPERS FORWARD VISION. FLIGHT RESEARCH CENTER TEST PILOTS SHALL FLY SHUTTLE CRAFT TERMINAL APPROACHES AND PERFORM LANDINGS WITH APPROACH ANGLES AND VELOCITIES AS VARIABLES. HIGH PERFORMANCE AIRCRAFT WITH VARIABLE CANOPY VISIBILITY SHALL BE UTILIZED FOR THIS PROGRAM.

RTOP NO. 127-51-29 TITLE:

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS ACTIVITY IS TO CONDUCT INVESTIGATIONS TO DETERMINE SPACE SHUTTLE PERSONNEL AND CARGO TRANSFER TECHNIQUES AND SUPPORT EQUIPMENT REQUIRED FOR BOTH 1 "G" AND 0 "G" CONDITIONS. THIS INFORMATION WILL BE USED IN MANNED SPACE SHUTTLE DESIGN STUDIES FOR ACTUAL DESIGN OF THE OPERATIONAL HARDWARE.

IT IS ALSO NECESSARY TO DETERMINE THE ASTRONAUT'S ABILITY AND EQUIPMENT REQUIRED TO PROVIDE IN-FLIGHT SUPPORT OF SHUTTLE NORMAL OPERATIONS, MAINTENANCE AND REPAIR, PERSONNEL RESCUE, SATELLITE RETRIEVAL, AND VEHICLE ACTIVATION WITH EMPHASIS ON EXTRAVEHICULAR ACTIVITIES. THE APPROACH TAKEN WILL BE TO INVESTIGATE PROPOSED SHUTTLE CONFIGURATIONS AND MISSION PLANS TO DETERMINE AREAS REQUIRING DETAILED STUDY, THEN TO CONDUCT ANALYTICAL STUDIES AND DETAILED SIMULATION OF VARIOUS TRANSFER TECHNIQUES USING FULL-SCALE SHUTTLE MOCKUPS AND LANGLEY WATER IMMERSION FACILITIES. ALSO, IT WILL BE NECESSARY TO IDENTIFY EQUIPMENT REQUIRED TO SUPPORT ASTRONAUT

ACTIVITIES RELATED TO SHUTTLE OPERATIONS, MAINTENANCE AND REPAIR, ASTRONAUT RESCUE, AND SATELLITE RETRIEVAL. REPEATED TESTS WILL ALLOW REFINEMENT OF TECHNIQUES AND DEFINITION OF EQUIPMENT REQUIRED FOR THE FLIGHT SYSTEM. THE SHUTTLE MISSION REQUIRES LOADING CREW, PASSENGERS, AND CARGO INTO A VERTICAL VEHICLE ON THE LAUNCH PAD AND THEN TRANSFER OF CARGO AND PERSONNEL TO THE SPACE STATION UNDER SPACE ENVIRONMENT, ZERO GRAVITY CONDITIONS. TECHNIQUES AND EQUIPMENT MUST BE DEVELOPED TO ACCOMPLISH THESE TASKS UNDER NORMAL AND EMERGENCY CONDITIONS.

RTOP NO. 127-51-30 TITLE: MAN/SYSTEM INTEGRATION AND HABITABILITY  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: NELSON, C. H. TEL.  
TECHNICAL SUMMARY

MSFC SHALL CONTINUE TO IDENTIFY THOSE AREAS WHEREIN MAN AS AN ELEMENT OF THE TOTAL ON-BOARD SYSTEM PROVIDES UNIQUE AND INDISPENSABLE FUNCTIONS. UPON THE IDENTIFICATION OF THESE FUNCTIONS NECESSARY HARDWARE DESIGN REQUIREMENTS AND CONSTRAINTS WILL BE DEVELOPED. THESE CRITERIA WILL BE APPLIED TO THE DEVELOPMENT OF SPECIAL TOOLS AND TECHNIQUES FOR MAINTENANCE AND REPAIR OF SPACE VEHICLES. MAN MUST BE ADEQUATELY ACCOMMODATED AS WELL AS EFFECTIVELY UTILIZED. TO THIS END PREVIOUS WORK AIMED AT DEVELOPMENT OF HABITABILITY CRITERIA WILL BE CONTINUED AND VERIFIED THROUGH EXPERIMENTAL TECHNIQUES.

RTOP NO. 127-53-19 TITLE: AVIATION SAFETY AND PROTECTION  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: CARPENTER, L. R. TEL. 805-258-3311  
TECHNICAL SUMMARY

RESEARCH TO DATE IN PROTECTIVE AND RESTRAINT DEVICES HAS NOT BEEN ORIENTED TOWARDS AN INTEGRATED IMPACT SURVIVAL SYSTEM. THIS RTOP IS TO STUDY THE PROBLEMS OF PRODUCING A UNIFIED INTEGRATED SAFETY SYSTEM TO PROTECT CREWS DURING THOSE SITUATIONS WHICH REQUIRE THE MAXIMUM IN INDIVIDUAL SAFETY PROTECTION BUT WHICH MAY OCCUR IN VEHICLES WHICH CANNOT UTILIZE EJECTION SEAT TECHNOLOGY. THE IMMEDIATE APPLICATION IS TO RESEARCH VEHICLES, PARTICULARLY, FLEXWING AND LIFTING BODY CONFIGURATIONS. THE APPROACH IS TO DESIGN, DEVELOP AND FABRICATE PROTECTIVE SYSTEMS FOR RESEARCH FLIGHT VEHICLES AND MEASURE THEIR CAPABILITIES DURING INSTRUMENTED DROP TESTS AND FLIGHT TESTS, AND UTILIZE THE DATA SO OBTAINED TO DESIGN SYSTEMS FOR MANNED FLIGHTS.

RTOP NO. 127-53-19 TITLE: AVIATION SAFETY AND PROTECTION  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: KLEIN, H. P. TEL. 415-961-1111  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP AN ADVANCED AIRCREW OXYGEN SYSTEM THAT WILL REPLACE LIQUID OXYGEN SYSTEMS CURRENTLY IN

USE ON TACTICAL AIRCRAFT AND TO DEVELOP IMPROVED AIRCRAFT SEATING AND RESTRAINT SYSTEMS FOR HIGH SPEED COMMERCIAL AIRCRAFT. THIS RESEARCH IS BEING CONDUCTED THROUGH CONTRACTUAL EFFORTS UNDER THE TECHNICAL DIRECTION OF AMES RESEARCH CENTER. A. THE ADVANCED AIRCREW OXYGEN SYSTEM BEING DEVELOPED WILL REDUCE OPERATIONAL COSTS AND MAINTENANCE; IT WILL ALLOW LONGER AIRCRAFT MISSION DURATIONS AND WILL ELIMINATE MANY OF THE SAFETY HAZARDS ASSOCIATED WITH LIQUID OXYGEN. THE NEW SYSTEM IS A CLOSED-LOOP SYSTEM THAT UTILIZES ELECTROCHEMICAL TECHNIQUES FOR PRODUCING OXYGEN AND FOR SCRUBBING CARBON DIOXIDE ABOARD THE AIRCRAFT. THE ELECTROCHEMICAL TECHNIQUES ARE DIRECTLY APPLICABLE TO SPACECRAFT LIFE SUPPORT SYSTEMS. B. RESEARCH IS BEING CONDUCTED TO INVESTIGATE AND DESIGN AN AIRCRAFT PASSENGER SEAT THAT WILL PROVIDE IMPACT PROTECTION, COMFORT, AND SAFETY. NEW SEAT RESTRAINT SYSTEMS AND CUSHION MATERIALS ARE BEING CONSIDERED FOR USE IN ATTENUATING HORIZONTAL AND VERTICAL VIBRATIONS AND HIGH IMPACT G LOADS.

RTOP NO. 127-53-20 TITLE: ATMOSPHERE STORAGE, GENERATION AND  
CONTAMINANT CONTROL

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-1111

TECHNICAL SUMMARY

REGENERATION OF OXYGEN FROM METABOLIC WASTES FOR LONG DURATION SPACE MISSIONS IS BEING STUDIED. SPECIFICALLY, OXYGEN RECOVERY FROM WASTE WATER USING A WATER VAPOR ELECTROLYSIS CELL IS BEING STUDIED. FOUR PROTOTYPE ELECTROLYZERS EACH CAPABLE OF GENERATING 2 LBS O<sub>2</sub>/DAY ARE TO BE TESTED DURING FY 70. CYCLIC OPERATION OF VAPOR CELLS WILL ALSO BE CONDUCTED IN AN ATTEMPT TO IMPROVE POWER EFFICIENCY. AN ALTERNATE APPROACH TO OXYGEN RECLAMATION, I.E., CO<sub>2</sub> ELECTROLYZER (ONE-MAN UNIT) WHICH UTILIZES ZIRCONIA-SCANDIA DISK ELECTROLYTES WILL BE ASSEMBLED AND TESTED DURING FY 70 IN CONJUNCTION WITH A CO DISPROPORTIONATOR. EMPHASIS WILL BE PLACED ON IMPROVING CELL DESIGN, MATERIALS FOR CONSTRUCTION, OPTIMIZING OPERATING CONDITIONS, AND LIFE TESTING. RESEARCH RELATING TO THE DEVELOPMENT OF REGENERABLE SORBENTS FOR NO, NO<sub>2</sub> AND CO<sub>2</sub> WILL BE CONTINUED. LABORATORY EXPERIMENTS ON THE ADSORPTION OF NO AND NO<sub>2</sub> ON MOLECULAR SIEVES WILL BE PURSUED IN FY 70 AND SUITABLE PURIFICATION UNITS WILL BE TESTED IN FY 71. CONCENTRATION OF CO<sub>2</sub> IS REQUIRED FOR SOME OXYGEN RECOVERY SUBSYSTEMS SUCH AS BOSCH OR SABATIER REACTORS AND IS ALSO ESSENTIAL FOR REMOVAL OF CO<sub>2</sub> FOR SHORTER TERM MISSIONS THAT DO NOT REQUIRE OXYGEN RECOVERY. LABORATORY EXPERIMENTS ON ADSORPTION-DESORPTION OF CO<sub>2</sub> (USING BOTH DOPED AND UNDOPED METAL OXIDES) WILL BE CONTINUED, AND A FOUR-MAN HYDROGEN-DEPOLARIZED CO<sub>2</sub> CONCENTRATOR WILL BE DEVELOPED AND EVALUATED.

RTOP NO. 127-53-20 TITLE: SPACECRAFT ATMOSPHERE SUPPLY,  
REGENERATION, AND CONTROL

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

IT IS NECESSARY IN MANNED SPACEFLIGHT TO PROVIDE A HABITABLE ATMOSPHERE FOR THE CREW. GAS, PARTICULATE, AND MICROBIAL CONTAMINANTS MUST BE REMOVED OR CONTROLLED. OXYGEN AND A DILUENT MUST BE REPLENISHED. THESE REQUIREMENTS FOR SHORT MISSIONS ARE CURRENTLY MET, MAINLY WITH NONREGENERABLE SORBENTS, FILTERS AND REACTANTS. OXYGEN IS STORED AND A DILUENT IS NOT PROVIDED. HUMIDITY IS CONTROLLED BY CONDENSING VAPOR AND REMOVING THE CONDENSATE BY MECHANICAL AND CAPILLARY FORCES. FOR LONGER MISSIONS THE CONSERVATION OF MATERIAL, INCLUDING THE DILUENT, WILL BE A STRINGENT GOAL IN BOTH VEHICLE AND SYSTEM DESIGNS; HOWEVER, SOME REPLENISHMENT WILL BE NECESSARY AND WILL BE FROM STORED SUPPLIES. REGENERABLE SYSTEMS WITH VACUUM DESORBED MOLECULAR SIEVES WILL BE SUITABLE FOR REMOVING CO<sub>2</sub> FOR INTERMEDIATE DURATION MISSIONS. THE LONGER MISSIONS WILL REQUIRE "SAVING" METABOLICALLY PRODUCED CO<sub>2</sub> AND H<sub>2</sub>O AND THE RECOVERY OF A PORTION OR ALL OF THE OXYGEN, E.G., FUSED SALT, SOLID ELECTROLYTE RECLAMATION TECHNIQUES. CONTROL OF CONTAMINANTS WILL BE INCREASINGLY IMPORTANT AS MISSION DURATION INCREASES. CATALYTIC OXIDATION, E.G., INCOS, AND BOTH REGENERABLE AND NONREGENERABLE SORPTION WILL BE NECESSARY, E.G., SORBER TRACE CONTAMINANT R&D. HUMIDITY CONTROL WILL BENEFIT FROM THE APPLICATION OF NEW CONDENSATE SEPARATION TECHNIQUES WHICH WILL IMPROVE THE EFFICIENCY OF THE CONDENSATE RECOVERY, E.G., HYDROPHILIC/HYDROPHOBIC WATER SEPARATOR. OVERALL, LIFE SUPPORT SYSTEMS AND PROCESSES WILL REQUIRE IMPROVED PERFORMANCE AND EFFICIENCY FOR THE LONGER DURATION MISSIONS. DESIGN INFORMATION FOR REGENERABLE AND RECLAMATION TYPE SYSTEMS WILL NEED TO BE COMPREHENSIVE AND THOROUGH IN ORDER TO MEET SPECIFIC, YET FUTURE, APPLICATIONS.

RTOP NO. 127-53-21 TITLE: SPACECRAFT WATER RECLAMATION AND WASTE  
MANAGEMENT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

THE NEED FOR WATER RECLAMATION SYSTEMS ABOARD FUTURE SPACECRAFT IS WELL RECOGNIZED. THE REQUIREMENT FOR ECONOMICAL, RELIABLE, AND EASILY MAINTAINED SYSTEMS WHICH PROVIDE WATER, MEETING THE POTABILITY STANDARDS OF CHEMICAL AND BIOLOGICAL PURITY FOR THE ENTIRE MISSION DURATION IS THE OBJECT OF THE CURRENT RESEARCH AND DEVELOPMENT PROGRAMS. THE WORK WILL ENCOMPASS THE RECLAMATION OF WATER FROM VARIOUS WASTES; URINE, HUMIDITY CONDENSATE, WASH WATER, AND OTHERS; THE DEVELOPMENT OF WASTE MANAGEMENT SYSTEMS AND TREATMENT OF THESE WASTES, AND WORK ON PHASE SEPARATION DEVICES, SUCH AS BUBBLE SEPARATORS IN LIQUID TRANSPORT LINES. THE PLANNED EFFORTS IN THIS AREA CONSIST, FOR THE MOST PART, OF EXTENSIONS AND FOLLOW-ON WORK PREVIOUSLY INITIATED. CONTRACT EFFORTS WILL CONTINUE IN BOTH THE VAPOR DIFFUSION PROCESS AND THE ELECTROLYSIS-ELECTRODIALYSIS PROCESS. BOTH OF THESE EFFORTS WILL INCLUDE THE CONSTRUCTION AND TESTING OF

PROTOTYPE DEMONSTRATOR UNITS, BY WHICH THE FEASIBILITY OF THE DESIGN CONCEPT, AND MORE BASICALLY, THE WORTH OF THE PROCESS AS APPLICABLE TO FUTURE SPACECRAFT MAY BE ASCERTAINED. ADDITIONAL HARDWARE FOR THE ILSS UPGRADING OF THE AIR EVAPORATION UNITS WILL BE OBTAINED, ASWELL AS THE DESIGN AND FABRICATION OF INTEGRATION INTERFACES FOR ADVANCED WATER RECLAMATION SYSTEMS SUCH AS THE VAPOR DIFFUSION WATER RECLAMATION SYSTEM. THE DESIGN, FABRICATION, AND TEST EFFORT FOR A PROTOTYPE CONTINUOUS WET OXIDATION SYSTEM WILL BE UNDERTAKEN AND WORK WILL CONTINUE ON THE HYDROPHOBIC-HYDROPHILIC PHASE SEPARATORS, AS APPLIED TO THE SEPARATION OF GAS BUBBLES FROM LIQUID TRANSPORT LINES. IN-HOUSE EFFORTS WILL BE APPLIED TO CONTINUED INVESTIGATION AND TEST OF NON-AEROSOL CONDENSING SEPARATORS FOR HUMIDITY CONTROL IN ZERO "G" ENVIRONMENTS; AN INSTRUMENT FOR THE MEASUREMENT OF THE PARTICLE SIZE DISTRIBUTION OF WATER AEROSOLS; AND INVESTIGATION OF ION TRANSPORT IN A THREE-COMPARTMENT SYSTEM.

RTOP NO. 127-53-21 TITLE: WATER AND WASTE MANAGEMENT  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: KLEIN, H. P. TEL. 415-961-1111  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO PROVIDE SUITABLE MANAGEMENT DEVICES AND TECHNIQUE FOR (1) STORING AND HANDLING LIQUID AND SOLID WASTES DURING SPACE MISSIONS OF LONG DURATION AND (2) RECOVERING USABLE WATER UNDER THE SAME CIRCUMSTANCES. THE DEGREE OF SUITABILITY AND SOPHISTICATION OF A SYSTEM AVAILABLE AT ANY GIVEN DATE WILL BE HIGHLY DEPENDENT UPON THE R+D EFFORT EXPENDED SINCE ONLY BY BETTER DEFINITION OF THE CAPABILITIES OF ANY GIVEN APPROACH SUCH AS INCINERATION OR ANAEROBIC SLUDGE DIGESTION IN THE AEROSPACE ENVIRONMENT CAN RATIONAL TRADEOFFS AND SELECTIONS BE MADE. CURRENTLY, INCINERATION SEEMS TO OFFER SOME ADVANTAGES AND IT IS PROBABLE THAT AN AUTOMATED 4-6 MAN MODEL COULD BE DESIGNED AND TESTED BY FY 74. THE GASEOUS PRODUCTS WOULD BE STERILE AND IT SHOULD BE POSSIBLE TO RECOVER THE WATER ORIGINALLY PRESENT PLUS THAT PRODUCED DURING COMBUSTION ALTERNATIVE APPROACHES TO WATER RECOVERY WILL INVOLVE CONSIDERATION OF PROCESSES SUCH AS EVAPORATION, DISTILLATION AND ULTRAFILTRATION. AGAIN, IT IS EXPECTED THAT AN ADEQUATE ALTHOUGH NOT NECESSARILY OPTIMUM SYSTEM FOR 4-6 MEN WILL BE AVAILABLE BY FY 74. IN SUBSEQUENT YEARS, SYSTEMS WITH IMPROVED CONVENIENCE, RELIABILITY, AND CAPACITY WOULD BE DEVELOPED TOGETHER WITHANCILLARY SYSTEMS TO REUTILIZE PRODUCTS OTHER THAN WATER. BY FY 80, A SYSTEM OF ANY REASONABLE CAPACITY COMPLETELY INTEGRATED INTO A CLOSED LIFE SUPPORT SYSTEM WOULD BE AVAILABLE.

RTOP NO. 127-53-22 TITLE: INTEGRATED LIFE SUPPORT SYSTEMS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: KLEIN, H. P. TEL. 415-961-1111  
TECHNICAL SUMMARY

A MAJOR PROBLEM IN INTEGRATED LIFE SUPPORT SYSTEMS FOR MISSIONS OF LONG DURATION IS PROVISION OF FOOD DERIVED FROM PRODUCTS OF METABOLISM. CLOSURE OF THE FOOD LOOP WOULD RESULT IN SIGNIFICANT



SAVINGS IN WEIGHT AND VOLUME FOR MISSIONS EXCEEDING A FEW THOUSAND MAN-DAYS IN DURATION. BIOLOGICAL, PHYSICOCHEMICAL AND COMBINED SYSTEMS ARE UNDER CONSIDERATION. PRODUCTS SUCH AS HYDROGENOMONAS EUTROPHA AND ALGAE DERIVED FROM BIOLOGICAL PROCESSES ARE OF LIMITED UTILITY BECAUSE OF HIGH NUCLEIC ACID AND PROTEIN SOURCES. PHYSICOCHEMICAL METHODS CAN BE USED TO OBTAIN CARBOHYDRATES AND OTHER COMPOUNDS WHICH SHOULD BE TOLERATED BY HUMANS AS A MAJOR PORTION OF THE DIET. PROTOTYPE DEVICES ARE BEING DEVELOPED WHICH WILL USE THE CO<sub>2</sub> AND H<sub>2</sub>O FROM METABOLISM AS RAW MATERIALS. THE PURE NUTRIENTS WILL ALSO BE EVALUATED AS ENERGY SOURCES FOR THE GROWTH OF DESIRABLE MICROORGANISMS. AS DESIGN DATA BECOMES AVAILABLE, INTEGRATED SYSTEMS WILL BE DEVELOPED.

RTOP NO. 127-53-22 TITLE: INTEGRATED LIFE SUPPORT SYSTEMS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: NELSON, C. H. TEL. 703-827-3285  
TECHNICAL SUMMARY

LABORATORY MODELS OF REGENERATIVE LIFE SUPPORT COMPONENTS ARE BEING SCALED-UP TO FULL SCALE, WORKING, MULTI-MAN SIZED SUBSYSTEMS. THE SCALE-UP INCLUDES DESIGNING FOR GRAVITY INDEPENDENT OPERATION, RELIABILITY AND MAINTAINABILITY, AND FLIGHT TYPE CONFIGURATION. SUBSEQUENTLY, THE SUBSYSTEMS ARE BEING INTEGRATED INTO COMPLETE LIFE SUPPORT SYSTEMS WHICH ARE USED EXPERIMENTALLY TO IDENTIFY AND SOLVE THE INTEGRATED ENGINEERING AND MAN-SYSTEM INTERFACE TECHNOLOGY PROBLEMS. SPECIFIC TECHNICAL AREAS BEING INVESTIGATED INCLUDE THE LONG TERM MECHANICAL PERFORMANCE OF THE HARDWARE, EFFICIENCIES AND GRAVITY INDEPENDENCY OF THE REGENERATIVE PROCESSES, AND CONTROL OF CHEMICAL AND MICROBIOLOGICAL CONTAMINANTS.

RTOP NO. 127-53-23 TITLE: ASTRONAUT PROTECTIVE SYSTEMS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: NELSON, C. H. TEL. 703-827-3285  
TECHNICAL SUMMARY

BECAUSE ASTRONAUT PERFORMANCE IN SPACE IS DEPENDENT ON HIS FREEDOM OF MOVEMENT, EFFORTS WILL BE MADE TO DETERMINE METHODS FOR CORRECTING THE CURRENT DEFICIENCIES OF SPACE SUITS WHEREIN MOBILITY AT INTENDED PRESSURES IS POOR. SUCCESSFUL METHODS FOR SUCH CORRECTION WILL BE INCORPORATED IN A SUIT FOR PROOF OF PRINCIPLE. TWO METHODS ARE UNDER STUDY - THE FIRST IS EFFECTIVELY THE APPLICATION OF PASSIVE ASSISTIVE DEVICES TO CONVENTIONAL SUIT JOINTS AND IS TERMED THE EQUIPOTENTIAL SUIT JOINT. THIS METHOD HAS INDICATED MARKED REDUCTIONS IN FORCE REQUIREMENTS. THE SECOND METHOD UNDER CONSIDERATION IS A TECHNIQUE WHICH USES THE PRINCIPLE OF APPLYING PRESSURE TO THE BODY BY THE MECHANICAL STRAINING OF THE SUIT MATERIAL RATHER THAN THROUGH INFLATED SUIT PRESSURE. THIS TECHNIQUE APPEARS TO OFFER THE POTENTIAL OF A MORE MOBILE AND LESS BULKY SUIT THAN THOSE OF CONVENTIONAL CONSTRUCTION AND IT WILL BE STUDIED FURTHER THROUGH A SERIES OF EXPERIMENTAL TESTS.

RTOP NO. 127-53-23 TITLE: ASTRONAUT PERSONAL SUPPORT SYSTEMS  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: BELL, L. E. TEL. 713-483-4278  
TECHNICAL SUMMARY

EXTENSION OF EXISTING TECHNOLOGY BASES ARE REQUIRED TO SUPPORT THE ASTRONAUT IN THE CONCEPT OF THE SPACE BASE FOR THE LATE 1970 AND 1980'S. SPECIFIC AREAS FOR INVESTIGATION: INCLUDE: A) SPACE SUITS: THESE DEVELOPMENTS WILL BE AIMED AT OPTIMIZATION OF THE CONSTANT VOLUME EXTRA VEHICULAR SPACE SUIT CONCEPTS SUCH THAT WORK REQUIRED TO ACCOMPLISH EV TASKS IS REDUCED WHILE MOBILITY IS ENHANCED. B) PORTABLE LIFE SUPPORT SYSTEMS AND RELATED EQUIPMENT: SIZING REQUIREMENTS DUE TO BOTH MISSION DURATION AND INCREASED WORK LOADS WHILE EV WILL REQUIRE THE OPTIMIZATION AND EXTENSION OF CURRENT CAPABILITIES. C) PERSONAL INSTRUMENTATION: THIS CATEGORY INCLUDES BIOINSTRUMENTATION SYSTEMS, TOXICS GAS SENSING, AND FIRE DETECTION. THE MEASUREMENTS ARE LUMPED INTO THESE CATEGORIES BECAUSE THEY ARE EITHER 1) INTIMATE TO THE ASTRONAUT, 2) CONTAINED WITHIN HIS SPACE SUIT, OR 3) CARRIED ON BOARD BY THE ASTRONAUT TO MONITOR THE SAFETY OF THIS ENVIRONMENT. D) CREW PROVISIONS: THE OBJECTIVE OF THIS TASK IS TO INVESTIGATE THE EXPECTED GFE/CREW PROVISIONS REQUIREMENTS TO BE SUPPLIED FOR THE 1970-1975 PERIOD. THIS GFE WILL BE APPLICABLE TO LUNAR EXPLORATION, LUNAR BASE AND SPACE STATION MISSIONS.

RTOP NO. 127-53-23 TITLE: ASTRONAUT PROTECTIVE SYSTEMS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: KLEIN, H. P. TEL. 415-961-1111  
TECHNICAL SUMMARY

ADVANCED MISSIONS WILL REQUIRE LIFE SUPPORT AND PROTECTIVE SYSTEMS CAPABLE OF PROVIDING A MICROENVIRONMENT FOR CONSIDERABLY LONGER DURATIONS THAN ARE PRESENTLY AVAILABLE. RECENT INDEPENDENT ADVANCEMENTS IN SUIT PERFORMANCE, THERMAL CONTROL SYSTEMS AND SOLID OXYGEN SOURCES WILL PROVIDE THE SPRINGBOARD FOR THE DEVELOPMENT OF AN ADVANCED EXTRAVEHICULAR PROTECTIVE SYSTEM (AEPS). THE OVERALL APPROACH IN ACCOMPLISHING THIS OBJECTIVE WILL BE TO CONTINUE THOSE IN-HOUSE EFFORTS DIRECTED AT IDENTIFYING THE BASIC PROBLEMS AND SOLUTIONS, CONTRACTUAL EFFORTS WILL BE INITIATED FOR TOTAL SYSTEMS INTEGRATION AND DEVELOPMENT.

RTOP NO. 127-53-24 TITLE: MANNED SPACECRAFT MONITORING AND CONTROL  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: LEAVITT, W. Z. TEL. 617-494-2417  
TECHNICAL SUMMARY

AN INTEGRATED PLAN FOR DETERMINATION OF THE ENVIRONMENTAL PARAMETERS AFFECTING MAN ON EXTENDED SPACE FLIGHT MISSIONS IS BEING EVOLVED THROUGH THEORY, DESIGN AND BREADBOARDING OF INSTRUMENTS FOR MEASUREMENT AND CONTROL OF THE SPACECRAFT ENVIRONMENT. IN AEROSOL PARTICLE ANALYSIS SUPPORT FOR FLIGHT EXPERIMENT T-003 IS BEING UNDERTAKEN BY DEVELOPMENT OF CALIBRATION METHODS FOR THE ANALYZER, INVESTIGATION OF PARTICULATE MATTER FOUND IN SPACECRAFT FROM APOLLO FILTERS, AND PARTICIPATION IN SIMULATOR TESTS. PHYSIOLOGICAL

PARTICULATE DEPOSITION IN WEIGHTLESSNESS IS BEING INVESTIGATED FOR DETERMINING SIZE FRACTIONS OF IMPORTANCE TO ASTRONAUTS' HEALTH. FOR GASEOUS CONTAMINANTS, EFFORTS ARE CONTINUING ON DEVELOPMENT OF MASS SPECTROMETER SOURCES TO MINIMIZE MOLECULAR FRAGMENTATION. FIELD IONIZATION AND CHARGE TRANSFER SOURCES ARE BEING INVESTIGATED.

RTOP NO. 127-53-24 TITLE: LIFE SUPPORT AND PROTECTIVE SYSTEMS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: GUY, W. W.

TEL. 703-483-3771

#### TECHNICAL SUMMARY

THIS EFFORT IS REQUIRED TO INSURE A FIRM TECHNOLOGY BASE TO SUPPORT ADVANCED MANNED MISSIONS IN THE AREA OF ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEMS. THERE ARE TWO AREAS OF SPECIFIC CONCENTRATION: 1) ATMOSPHERIC STORAGE, GENERATION AND CONTAMINANT CONTROL: SPECIFIC TASKS IN THIS AREA INCLUDE DEVELOPMENT OF NON-CRYOGENIC ATMOSPHERIC SUPPLY SYSTEMS, NON-CONDENSING HUMIDITY CONTROL SYSTEMS, REFRIGERATION SYSTEMS, ATMOSPHERIC MONITORING AND CONTROL TECHNIQUES, AND IMPROVED ANALYTICAL MODELS OF THE CO<sub>2</sub> COLLECTION AND REDUCTION PROCESS. 2) WATER AND WASTE MANAGEMENT: SPECIFIC EFFORTS IN THE AREAS OF WATER AND WASTE MANAGEMENT INCLUDE INVESTIGATION OF STERILIZATION METHODS, DEVELOPMENT OF WATER POTABILITY ASSESSMENT EQUIPMENT, DEVELOPMENT OF IMPROVED WASTE COLLECTION TECHNIQUES AND DEVELOPMENT OF WATER RECOVERY HARDWARE. INVESTIGATION OF NONMETALLIC MATERIALS WILL BE CONCERNED WITH THREE SPECIFIC AREAS: 1) FLAMEPROOF ORGANIC FIBER, 2) FLAMEPROOF CONSTANT WEAR GARMENT, AND 3) DEVELOPMENT OF NONFLAMMABLE POLYMER. THE OBJECTIVE OF THE MASS SPECTROMETER PROGRAM IS TO DEVELOP AN INSTRUMENT CAPABLE OF MONITORING THE CONCENTRATION LEVELS OF THE CRITICAL COMPONENTS OF THE SPACECRAFT ATMOSPHERE OTHER THAN CARBON DIOXIDE.

RTOP NO. 127-53-24 TITLE: SPACECRAFT ATMOSPHERE AND SYSTEMS

INSTRUMENTATION AND CONTROL

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H.

TEL. 703-827-3285

#### TECHNICAL SUMMARY

WITH INCREASING SPACECRAFT MISSION DURATION AND SYSTEMS COMPLEXITY, A NUMBER OF INSTRUMENTS MUST BE DEVELOPED TO PROVIDE FOR PROPER MONITORING AND CONTROL OF SYSTEMS AND PROCESSES WHICH SUPPORT MAN IN SPACE. THE MOST CRITICAL MEASUREMENTS ARE: THE MAJOR CONSTITUENTS OF THE ATMOSPHERE; THE IDENTIFICATION AND QUANTIFICATION OF THE CHEMICAL, BACTERIOLOGICAL AND PARTICULATE CONTAMINANTS THAT ARE GIVEN OFF WITHIN THE VEHICLE AND WHICH PRESENT A HAZARD TO MAN'S PROFICIENCY AND WELL-BEING; THE MONITORING OF THE OPERATION OF THE LIFE SUPPORT PROCESSES THEMSELVES, TO VERIFY CONTINUED PROPER FUNCTIONING; AND A MEASURE OF THE PURITY OF THE WATER PROVIDED BY THE WATER STORAGE AND RECLAMATION SYSTEMS. THE WORK CURRENTLY IN PROGRESS, CONSISTS OF RESEARCH AND DEVELOPMENT OF DISPERSED O<sub>2</sub> PARTIAL PRESSURE SENSORS, THE DEVELOPMENT OF A FLIGHT CAPABLE CONTAMINANT SENSOR CAPABLE OF SENSING A NUMBER OF CONTAMINANTS WHICH

ARE FELT TO BE A SIGNIFICANT PROBLEM ABOARD THE NEXT GENERATION SPACECRAFT, SUCH AS HYDROGEN, METHANE, CARBON MONOXIDE AND A MEASURE OF TOTAL ORGANICS. THESE CONTAMINANTS WILL BE SENSED, IN ADDITION TO THE MAJOR CONSTITUENTS, IN ONE MINIATURIZED MASS SPECTROMETER. IN ADDITION, STUDY AND DESIGN EFFORTS WILL BE INITIATED ON A MASS SPECTROMETER-PRECONCENTRATOR PACKAGE WHICH WILL HAVE THE CAPABILITY TO DETECT AND IDENTIFY A LARGE NUMBER OF TRACE CONTAMINANTS. THIS EFFORT IS DIRECTED SPECIFICALLY TOWARD THE LONGER-DURATION SPACECRAFT WITH LOWER LEAK RATES. IN-HOUSE EFFORTS ARE UNDERWAY TO DEVELOP A TECHNIQUE FOR IDENTIFYING MICRO-ORGANISMS UNAMBIGUOUSLY, WHICH MAY BE PRESENT IN THE ATMOSPHERE AND POTABLE WATER SUPPLIES. WORK IS BEING CONDUCTED TO BETTER ESTABLISH THE QUANTITATIVE CAPABILITY AND FURTHER DEFINE THE ABSORPTION SPECTRA OF CONTAMINANTS FOR MICROWAVE SPECTROSCOPY; AND TO CONDUCT BASIC AND APPLIED RESEARCH TO THE UNDERSTANDING AND UTILIZATION OF INHOMOGENEOUS MAGNETIC FIELDS FOR MASS SPECTROMETRY.

RTOP NO. 127-53-25 TITLE: EARTH ORBIT LOGISTICS - PERSONAL  
PROTECTIVE SYSTEMS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: NELSON, C. H. TEL. 713-483-4933

TECHNICAL SUMMARY

IT IS NOT CONSIDERED ACCEPTABLE THAT THE CREW AND PASSENGERS OF THE SHUTTLE CRAFT BE REQUIRED TO WEAR SPACE SUITS AS ROUTINE OPERATIONAL PROTECTIVE SYSTEMS. HOWEVER, A CONSTANT WEAR SPACE SUIT MUST BE PROVIDED TO SUPPORT EARLY FLIGHT TESTS AND EARLY OPERATIONAL FLIGHTS. OBJECTIVES: TO PROVIDE A LIGHT WEIGHT CONSTANT WEAR SPACE SUIT TO BE USED DURING FLIGHT TEST PHASES OF THE SHUTTLE CRAFT AND EARLY OPERATIONAL FLIGHTS. APPROACH: TWO APPROACHES ON SPACE SUITS WILL BE PURSUED. THE FIRST, UTILIZING THE MECHANICAL COUNTER PRESSURE TECHNIQUE, WILL BE CONTINUED UNDER EXISTING CONTRACT. THE SECOND APPROACH, A LIGHT WEIGHT SIMPLIFIED DESIGN FULL PNEUMATIC PRESSURE SUIT, WILL BE INITIATED IN LATE FY 70.

RTOP NO. 127-53-25 TITLE: EARTH ORBIT LOGISTICS-PERSONAL  
PROTECTIVE SYSTEMS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: NELSON, C. H. TEL. 713-483-4933

TECHNICAL SUMMARY

IT IS NOT CONSIDERED ACCEPTABLE THAT THE CREW AND PASSENGERS OF THE SHUTTLE CRAFT BE REQUIRED TO WEAR SPACE SUITS AS ROUTINE OPERATIONAL SYSTEMS. HOWEVER, AS CONSTANT WEAR SPACE SUIT MUST BE PROVIDED TO SUPPORT EARLY FLIGHT TESTS AND EARLY OPERATIONAL FLIGHTS. OBJECTIVES: TO PROVIDE A LIGHT WEIGHT CONSTANT WEAR SPACE SUIT TO BE USED DURING FLIGHT TEST PHASES OF THE SHUTTLE CRAFT AND EARLY OPERATIONAL FLIGHTS. APPROACH: TWO APPROACHES ON SPACE SUITS WILL BE PURSUED. THE FIRST, UTILIZING THE MECHANICAL COUNTER PRESSURE TECHNIQUE, WILL BE CONTINUED UNDER EXISTING CONTRACT. THE SECOND APPROACH, A LIGHT WEIGHT SIMPLIFIED DESIGN FULL PNEUMATIC PRESSURE SUIT, WILL BE INITIATED IN LATE FY 70

RTOP NO. 127-53-26 TITLE: EARTH ORBIT LOGISTICS - ATMOSPHERIC  
SENSING AND CONTROL

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: NELSON, C. H. TEL. 713-483-4933

TECHNICAL SUMMARY

THE SHUTTLE SPACECRAFT HAS SEVERAL UNIQUE REQUIREMENTS WHICH WILL REQUIRE SOME DEVIATIONS FROM THE FLIGHT SPACECRAFTS OF TODAY. IT WILL HAVE A SIGNIFICANTLY LARGER CREW WITH A VERY SHORT NOMINAL MISSION. HOWEVER, IT DOES HAVE A INTERMEDIATE LENGTH CONTINGENCY MISSION WHICH MUST ALSO BE ACCOMODATED. IT MUST BE EASILY REFURBISHED, IT MUST ACCOMODATE LONG QUIESCENT PERIODS. AND IT MUST POSSESS AN ATMOSPHERIC CONDITIONING SYSTEM WHICH CAN FUNCTION BOTH IN ORBIT AND DURING THE REENTRY AND LANDING PHASES OF THE MISSION. THERE ARE TWO AREAS WHICH NEED ATTENTION IN THE ATMOSPHERIC SENSING AND CONTROL AREA. (1) THE COOLING SYSTEM REQUIRED DURING THE ATMOSPHERIC FLIGHT AND LANDING PHASE OF THE MISSION WILL REQUIRE SPACECRAFT SYSTEMS NOT PREVIOUSLY NEEDED DUE TO THE VERY BRIEF ELAPSED TIME BETWEEN LOSS OF EVAPORATIVE COOLING AND SPLASHDOWN. (2) THE HUMIDITY CONTROL SYSTEM MUST ELIMINATE (A) THE PROCEDURAL PROBLEMS OF STARTUP AND (B) THE DESTRUCTION PROBLEMS OF SHUTDOWN, AND ENHANCE THE LIFE AND REUSE ASPECTS OF THE HARDWARE. OBJECTIVES: TWO AREAS WHICH NEED ATTENTION IN THE ATMOSPHERE CONTROL AREA ARE: (1) THE COOLING SYSTEM REQUIRED DURING THE ATMOSPHERIC FLIGHT AND LANDING PHASE OF THE MISSION WILL----

RTOP NO. 127-53-27 TITLE: EARTH ORBIT LOGISTICS - WATER AND WASTE  
MANAGEMENT SYSTEMS

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: NELSON, C. H. TEL. 713-483-4933

TECHNICAL SUMMARY

THE SHUTTLE SPACECRAFT WILL REQUIRE IMPROVEMENT IN THE WATER AND WASTE MANAGEMENT SYSTEMS AREA. THE SOLID WASTE MANAGEMENT SYSTEM MUST NOT REQUIRE MANUAL HANDLING AND MUST PROVIDE AUTOMATIC DISPOSAL AND/OR STORAGE. OBJECTIVES: THE WASTEMANAGEMENT SYSTEM TO BE PROVIDED TO THE SPACE SHUTTLE CREW AND PASSENGERS MUST NOT REQUIRE MANUAL HANDLING OF THE WASTE PRODUCTS AND MUST PROVIDE AUTOMATIC DISPOSAL AND/OR STORAGE. IT SHOULD BE AS CLOSE AS POSSIBLE TO STANDARD TOILET PROCEDURES. APPROACH: TO PROVIDE A TECHNOLOGY BASE FOR THE ABOVE DISCUSSED REQUIREMENTS, ACTIVITY MUST BE INITIATED IN A TIMELY MANNER ON THE PACING TECHNOLOGY ITEMS. ALTHOUGH NO STATE-OF-THE ART ADVANCEMENT IS ANTICIPATED TO ACCOMPLISH ANY OF THE ABOVE OBJECTIVES, POTENTIALLY----

RTOP NO. 127-53-28 TITLE: EARTH ORBIT LOGISTICS - THERMAL CONTROL

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: GUY, W. W. TEL. 713-483-3771

TECHNICAL SUMMARY

THIS RTOP WILL DELINEATE THE REQUIRED EFFORT TO SUPPORT ADVANCED MANNED MISSIONS (SHUTTLE SPACECRAFT) IN THE AREA OF ACTIVE THERMAL CONTROL SYSTEMS. INCLUDED WILL BE: (1) THE CONVERSION OF OART

SPONSORED RADIATOR CONCEPTS (WHICH HAVE PROVEN FEASIBILITY) INTO PROTOTYPE SYSTEMS BY APPLYING THE TECHNOLOGY ADVANCES TO THE SPECIFIC PROBLEM OF SHUTTLE HEAT REJECTION SYSTEMS WITH VEHICLE AND MISSION FLEXIBILITY AND; (2) EVAPORATIVE HEAT EXCHANGER CONCEPT DEVELOPMENT AND FEASIBILITY TESTING TO ACCOMMODATE HIGH HEAT LOAD SPIKES WITH MAXIMUM RELIABILITY WHILE RETAINING THE REUSE CAPABILITY. RESULTS OF THIS TASK WILL PROVIDE DEVELOPMENTAL HARDWARE EXPERIENCE FOR SHUTTLE SPACECRAFT THERMAL CONTROL SYSTEMS. OBJECTIVE: THIS RTOP WILL DELINEATE THE REQUIRED EFFORT TO SUPPORT ADVANCED MANNED MISSIONS (SHUTTLE SPACECRAFT) IN THE AREA OF ACTIVE THERMAL CONTROL SYSTEMS. INCLUDED WILL BE: (1) THE CONVERSION OF OART SPONSORED RADIATOR CONCEPTS (WHICH HAVE PROVEN FEASIBILITY) INTO PROTOTYPE SYSTEMS BY APPLYING THE TECHNOLOGY ADVANCES TO THE SPECIFIC PROBLEMS OF----

RTOP NO. 127-53-28 TITLE: PERSONNEL AND CABIN THERMAL CONTROL  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: CARPENTER, L. R. TEL. 805-258-3311  
TECHNICAL SUMMARY

PERSONNEL THERMAL CONTROL PROBLEMS HAVE BEEN ENCOUNTERED AT THE FLIGHT RESEARCH CENTER IN ALL LIFTING BODY CONFIGURATIONS BEING FLOWN. PRESENTLY WITHIN AVAILABLE FUNDING A PROGRAM IS UNDERWAY TO SOLVE THE THERMAL PROBLEM FOR MISSION DURATIONS TO TWO HOURS. A CHANGE IN TECHNICAL SCOPE IS BEING REQUESTED TO EXTEND THE CAPABILITIES OF THE PERSONNEL AND CABIN CONTROL SYSTEM TO MISSION DURATIONS OF SEVEN HOURS.

RTOP NO. 127-53-29 TITLE: MANNED SPACE SHUTTLE (CATEGORY II) LIFE SUPPORT SYSTEM ANALYSIS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: NELSON, C. H. TEL. 703-827-3285  
TECHNICAL SUMMARY

A LIFE SUPPORT SYSTEM IS REQUIRED FOR THE SPACE SHUTTLE WHICH IS CAPABLE OF OPERATING IN CONJUNCTION WITH THAT OF THE SPACE STATION/SPACE BASE SYSTEM, WHICH CAN BE STORED FOR LONG PERIODS IN ORBIT AND THEN STARTED WHICH HAS THE REQUIRED RELIABILITY AND SHORT TURN-AROUND-TIME REFURBISHMENT CHARACTERISTICS, AND WHICH HAS MINIMUM WEIGHT IN ORDER TO MAXIMIZE THE PAYLOAD CAPABILITY OF THE SHUTTLE. IN ORDER TO ASSURE TIMELY AVAILABILITY OF SHUTTLE LIFE SUPPORT SYSTEM TECHNOLOGY, A PRIMARY IN-HOUSE STUDY WILL BE MADE OF DATA AND SUBSYSTEMS APPLICABLE TO THE SHUTTLE MISSION, AND PROBLEM AREAS WILL BE IDENTIFIED. THEN CRITICAL COMPONENTS REQUIRED TO INVESTIGATE FACTORS SUCH AS SYSTEM STORAGE AND STARTUP AND INTERFACES BETWEEN THE OPEN-CYCLE SHUTTLE SUBSYSTEM AND REGENERATIVE SPACE STATION SUBSYSTEMS WILL BE PROCURED AND TESTED. ALSO, ADVANCES IN COMPONENT STATE-OF-THE-ART WILL BE CONTINUALLY EXAMINED IN AN EFFORT TO UPDATE SYSTEM RELIABILITY AND MINIMIZE WEIGHT. THE NOMINAL MISSION LENGTH OF 7 DAYS INDICATES THAT MAXIMUM USE SHOULD BE MADE OF APOLLO HARDWARE FOR THE SHUTTLE LIFE SUPPORT SYSTEM. HOWEVER, A TWO-GAS SHIRT SLEEVE CABIN ATMOSPHERE CONSISTING OF OXYGEN AND NITROGEN IS



REQUIRED, WHICH MEANS THAT ADDITION OF A SUPPLY OF STORED NITROGEN WILL BE NECESSARY AND ALSO A TWO-GAS ATMOSPHERE SENSOR AND CONTROL SYSTEM. ALSO, CONSIDERATION OF PASSENGERS WHO ARE NOT AS HIGHLY QUALIFIED OR AS WELL TRAINED AS ASTRONAUTS WILL REQUIRE MODIFICATIONS TO PERSONAL ACCOMADATION SYSTEMS INVOLVING WASTE MANAGEMENT AND CABIN TEMPERATURE CONTROL.

RTOP NO. 127-53-30 TITLE: AVIATION SAFETY AND PROTECTION  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: CARPENDER, L. R. TEL. 805-258-3311  
TECHNICAL SUMMARY

AT PRESENT, WORK IS PROGRESSING AT THE FLIGHT RESEARCH CENTER ON A LIGHTWEIGHT ENERGY ABSORBING SEAT. THIS SEAT HAS BEEN PLACED ON THE PARAGLIDER CONFIGURATION AND IS ALSO BEING USED IN COCKPIT CONFIGURATION STUDIES AND MOCKUPS OF LIFTING BODY VEHICLES. THIS CHANGE IN SCOPE OF AN EXISTING ACTIVITY IS SUBMITTED TO EXPAND THIS EFFORT TO INCLUDE A POSITIONAL CAPABILITY FOR THE ENERGY ABSORBING SEAT; THAT IS, TO PROVIDE THE PILOT OR PASSENGER THE MEANS TO REPOSITION THE SEAT DEPENDING ON REQUIREMENTS SUCH AS LANDING, DOCKING, SITTING, SLEEPING, OR FOR THE MOST COMFORTABLE POSITION DURING "G" LOADING.

RTOP NO. 127-53-31 TITLE: SPACE STATION VENTILATION SYSTEM DESIGN.  
ORGANIZATION: MSFC  
MONITOR: CARPENDER, L. R. TEL. 000453-1120  
TECHNICAL SUMMARY

PRESENT SPACE STATION COMPARTMENT LAYOUTS AND CONTINGENCY PLANS FOR PARTIAL OCCUPATION IN CASE OF EMERGENCIES NECESSITATE A COMPLEX BUT FLEXIBLE VENTILATION SYSTEM ARRANGEMENT. CAREFUL SYSTEM TRADEOFFS MUST BE MADE TO PROVIDE SYSTEM EFFICIENCY AND CREW COMFORT AND SAFETY. FOR EXAMPLE, STAGNATION AREAS MUST NOT EXIST IF LOCALIZED CONCENTRATIONS OF CO<sub>2</sub> ARE TO BE AVOIDED. THE OBJECTIVES OF THIS EFFORT ARE TO PERFORM VENTILATION SYSTEM DESIGN STUDIES IN SUPPORT OF AN IN-HOUSE STATION MOCKUP AND THE PROCUREMENT OF VENTILATION HARDWARE FOR INSTALLATION AND TESTING IN THE MOCKUP.

RTOP NO. 127-53-32 TITLE: MANNED SPACE SHUTTLE: STUDIES OF  
PERSONNEL RESTRAINT AND SUPPORT  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: KLEIN, H. P. TEL. 415-961-1111  
TECHNICAL SUMMARY

PROPOSED SPACE SHUTTLE OPERATION IMPOSES ON THE CREW AND PASSENGERS AN ACCELERATION ENVIRONMENT NEVER BEFORE ENCOUNTERED IN MANNED SPACE FLIGHT OR AIRCRAFT OPERATION. RESEARCH IS NECESSARY TO DEFINE ACCAPTABLE CREW AND PASSENGER RESTRAINT AND SUPPORT SYSTEMS FOR THE SPACE SHUTTLE. A SERIES OF EXPERIMENTS ARE PLANNED, USING AMES' SIMULATORS, TO PROVIDE THE INFORMATION NECESSARY TO DESIGN THE CREW AND PASSENGER STATIONS. PROFILES COMBINING -GX AND +GZ

ACCELERATION VECTORS IN THE RANGE OF 3 TO 4 G'S ARE PLANNED USING SUBJECTS REPRESENTATIVE OF THE SPACE SHUTTLE CREW AND PASSENGER POPULATION, I.E., PILOTS AND MALES AND FEMALES IN THE AGE GROUP 25 TO 50. THE EFFECT OF DECONDITIONING ON PASSENGER'S TOLERANCE TO ACCELERATION IS ALSO TO BE EXAMINED. IT IS PLANNED TO PROVIDE DESIGN AND PERFORMANCE CRITERIA FOR THE CREW AND PASSENGER STATIONS BY THE END OF FISCAL YEAR 1971.

RTOP NO. 128-31-16 TITLE: THRUST CHAMBERS AND INJECTORS  
ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: GREGORY, J. W. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE A BETTER UNDERSTANDING OF INJECTOR AND INJECTION ELEMENT DESIGN EFFECTS ON BOTH COMBUSTION EFFICIENCY AND THRUST CHAMBER HEAT TRANSFER, ALONG WITH DEVELOPMENT OF IMPROVED MATERIALS AND CHAMBER FABRICATION TECHNIQUES FOR LOWER COST, HIGHER HEAT FLUX, AND MORE DESIGN FLEXIBILITY (FOR CHANGES IN OPERATING CONDITIONS OR PROPELLANTS). IMPROVEMENTS IN THE ABILITY TO COPE WITH HIGH HEAT FLUX LEVELS WILL BE OBTAINED THROUGH THE DEVELOPMENT OF REFRACTORY METAL OR CERAMIC COATINGS APPLIED TO THE INNER WALLS OF REGENERATIVE CHAMBERS. INJECTOR TECHNOLOGY DEVELOPMENT PROGRAMS WILL BE UNDERTAKEN TO PROVIDE KNOWLEDGE ON THE EFFECT OF INJECTOR DESIGN VARIABLES UPON COMBUSTION EFFICIENCY AND ON HEAT FLUX TO THE THRUST CHAMBER WELLS. THIS PROGRAM WILL BE APPLIED PRINCIPALLY TO THE HIGH ENERGY CRYOGENIC AND SPACE STORABLE PROPELLANTS, ALTHOUGH MANY OF THE RESULTS WILL BE GENERALLY APPLICABLE TO OTHER PROPELLANTS.

RTOP NO. 128-31-58 TITLE: PROPULSION TECHNOLOGY FOR SPACE STATIONS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: GREGORY, J. W. TEL. 205-453-1120

TECHNICAL SUMMARY

NASA IS PLANNING AS ONE OF IT'S MAJOR OBJECTIVES IN THE LATE 1970 TIME FRAME A LARGE SPACE STATION WITH A USEFUL LIFE TIME OF AT LEAST 10 YEARS. THIS EXTREMELY LONG OPERATIONAL LIFETIME DICTATES THAT THE CONSUMABLES AND ENERGY FOR THE ACPS (ATTITUDE CONTROL PROPULSION SYSTEM) CANNOT BE COMPLETELY SUPPLIED INITIALLY. ONE APPROACH WHICH CAN BE TAKEN IS TO RESUPPLY THE SPACE STATION PERIODICALLY WITH CONSUMABLES, INCLUDING PROPELLANTS AND OTHER WORKING FLUIDS. THE RTOP CONSISTS PRESENTLY OF ONE TASK, TRANSFER OF FLUIDS BETWEEN LOGISTICS VEHICLE AND SPACE STATION.

RTOP NO. 128-31-59 TITLE: PROPULSION TECHNOLOGY FOR ADVANCED  
REUSABLE SHUTTLE VEHICLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: GREGORY, J. W. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE CONCEPTUAL DESIGNS AND DATA TO ENHANCE CAPABILITY OF PROPULSION SYSTEMS TO ACHIEVE EXTENSIVE OPERATIONAL VERSATILITY AND HIGH PERFORMANCE REQUIRED FOR EARTH ORBIT LOGISTICS TYPE VEHICLES, SUCH AS THE SPACE SHUTTLE. THIS EFFORT WILL INVESTIGATE NEW CONCEPTS AND TECHNIQUES THROUGH ANALYSIS, PRELIMINARY DESIGN AND SUBSCALE HARDWARE FEASIBILITY DEMONSTRATIONS. THREE TASKS ARE IDENTIFIED WHICH HAVE POTENTIAL FOR IMPROVEMENTS IN THE VARIABLE THRUST, TANK HEAD START AND APS THRUSTER COOLING REQUIREMENTS OF THE SPACE SHUTTLE. THESE EFFORTS PROVIDE FOR INVESTIGATIONS OF A DUAL COMBUSTOR THROTTLING TECHNIQUE, A TWO-PHASE INDUCER FOR TANK HEAD STARTS, AND A FILM COOLED O<sub>2</sub>H<sub>2</sub> COMBUSTION CHAMBER FOR THE SHUTTLE APS. BOTH IN-HOUSE AND CONTRACTED EFFORTS ARE PLANNED INCLUDING ANALYSIS, DESIGN, FABRICATION, AND TEST PHASES.

RTOP NO. 128-31-60 TITLE: TECHNOLOGY IDENTIFICATION & TEST  
MEASUREMENTS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MEEKS, P. TEL. 213-354-2546

TECHNICAL SUMMARY

THE GOALS OF THIS WORK ARE: (A) TO COORDINATE A GOVERNMENT/INDUSTRY EFFORT TO STANDARDIZE ON THE METHODOLOGY AND PROCEDURES UTILIZED IN THE CALCULATION OF PERFORMANCE OF ROCKET ENGINES -- PARTICULARLY AS APPLIED TO THE EXTRAPOLATION TO PERFORMANCE IN SPACE FROM GROUND LEVEL SUB-SCALE EXPERIMENTS. (B) DEVELOP SPECIAL INSTRUMENTATION AND DEVISE NEW TECHNIQUES FOR OBTAINING PERFORMANCE DATA FROM PROPULSION SYSTEMS. (C) WHEN THE NEED IS SPECIFIED, DEVELOP THE SOFTWARE REQUIRED TO IMPLEMENT AND VERIFY (A).

RTOP NO. 128-31-60 TITLE: TECHNOLOGY IDENTIFICATION AND TEST  
MEASUREMENTS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MEEKS, P. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO DEVELOP COMPREHENSIVE INSTRUMENTATION SYSTEMS THAT WILL BE ABLE TO PROVIDE A COMPLETE DESCRIPTION OF SUPERSONIC FLOW FIELDS, INCLUDING THE EFFECTS OF CHEMICAL REACTIONS. CURRENT EFFORTS TO OBTAIN SUCH A SYSTEM ARE DIRECTED TOWARD THE DEVELOPMENT OF OPTICAL MEASUREMENTS ARE BEING UTILIZED AND HAVE PROVEN TO BE EFFECTIVE FOR THE DETERMINATION OF TEMPERATURE, COMPOSITION, SPECIE PARTIAL PRESSURE, AND CHEMICAL REACTIONS. HOWEVER ADEQUATE ANALYSIS OF PRESENT AND FUTURE ENGINE SYSTEMS REQUIRES THAT THE FLOW FIELD STRUCTURE BE KNOWN IN DETAIL. THESE INSTRUMENTS ARE NEEDED IN ORDER TO DETERMINE THE FLOW FIELD STRUCTURE, WHICH IN TURN IS REQUIRED FOR AN ACCURATE ENGINE

PERFORMANCE ANALYSIS.

RTOP NO. 128-31-60 TITLE: TECHNOLOGY IDENTIFICATION

ORGANIZATION: HEADQUARTERS

MONITOR: LEVINE, R. S. TEL. 202-962-1703

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO ACCOMPLISH ACTIVITIES IN THE NATURE OF SPECIAL OR SELECTED PROJECTS. THESE PROJECTS FALL INTO FOUR DISTINCT CATEGORIES. (1) INTERDEPARTMENTAL PURCHASE REQUESTS WHICH ARE OF A GENERAL NATURE (2) PROJECTS WHICH ARE PART OF MULTI-CENTER EFFORTS, (3) TO EXPEDITIOUSLY IMPLEMENT AN EFFORT TO SATISFY A NEW OR URGENT REQUIREMENT, (4) TO INITIATE AN ACTIVITY TO SERVE AS A "SEED PROGRAM" FOR EXPANSION OF A CENTER'S EXISTING CAPABILITY.

RTOP NO. 128-31-61 TITLE: AUXILIARY PROPULSION SYSTEM COMPONENT TECHNOLOGY

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: NORED, D. L. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE IMPROVEMENTS IN THE TECHNOLOGY OF COMPONENTS FOR SMALL HYDROGEN-OXYGEN ENGINES. THESE ENGINES WOULD BE APPLICABLE TO THE AUXILIARY PROPULSION SYSTEM FOR THE SPACE SHUTTLE VEHICLE. THIS WORK WILL BE DEVOTED TO ADVANCEMENTS IN SUCH AREAS AS IGNITION SYSTEMS, PROPELLANT VALVES, BASIC INJECTION TECHNIQUES, AND COOLING. THE PROGRAM WILL BE PURSUED THROUGH BOTH ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS DESIGNED TO EVALUATE THOROUGHLY THE BASIC CRITICAL PROBLEMS UNIQUE TO EACH AREA AND TO ESTABLISH DATA NECESSARY FOR RELIABLE DESIGN. THE WORK WILL INCLUDE ANALYSIS AND DESIGN, COLD FLOW TESTING, WHERE APPLICABLE, WITH SIMULANT FLUIDS, AND HOT FIRING TESTS USING GASEOUS HYDROGEN-GASEOUS OXYGEN PROPELLANTS. AS NEW TECHNOLOGY NEEDS ARE IDENTIFIED BY THE VARIOUS SPACE SHUTTLE VEHICLE STUDIES, NEW EFFORTS WILL BE INITIATED, AS NECESSARY.

RTOP NO. 128-31-62 TITLE: TECHNOLOGY FOR AUXILIARY PROPULSION REUSABLE SHUTTLE VEHICLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: NORED, D. L. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE CONCEPTUAL DESIGNS AND DATA TO ENHANCE CAPABILITY OF PROPULSION SYSTEMS TO ACHIEVE EXTENSIVE OPERATIONAL VERSATILITY AND HIGH PERFORMANCE REQUIRED FOR EARTH ORBIT LOGISTICS TYPE VEHICLES, SUCH AS THE SPACE SHUTTLE. THIS EFFORT WILL INVESTIGATE NEW CONCEPTS AND TECHNIQUES THROUGH ANALYSIS, PRELIMINARY DESIGN AND SUBSCALE HARDWARE FEASIBILITY DEMONSTRATIONS. TWO TASKS ARE IDENTIFIED WHICH HAVE POTENTIAL FOR IMPROVEMENTS IN APS VARIABLE THRUST AND THRUSTER COOLING REQUIREMENTS WITH INCREASE IN RELIABILITY

BY SIMPLIFICATION WITH ELIMINATION OF COOLANT PASSAGE RESISTANCE PROBLEMS ASSOCIATED WITH REGENERATIVE COOLING WHILE PROVIDING THE PERFORMANCE CHARACTERISTICS REQUIRED FOR THE SHUTTLE. TWO TASKS ARE DEFINED UNDER THIS RTOP: (1) A FILM COOLED APS H<sub>2</sub>/O<sub>2</sub> COMBUSTOR INCORPORATING STEP THROTTLING WILL BE INVESTIGATED IN-HOUSE AT MSFC, AND (2) INCIPIENT BOILING DATA WILL BE ESTABLISHED FOR LH<sub>2</sub> IN A REDUCED GRAVITY ENVIRONMENT UNDER CONTRACT WITH THE UNIVERSITY OF MICHIGAN. THE IN-HOUSE AND CONTRACTED EFFORTS ARE PLANNED TO ENCOMPASS ANALYSIS, DESIGN, FABRICATION AND TESTING.

RTOP NO. 128-31-63 TITLE: TECHNOLOGY FOR MAIN PROPULSION, REUSABLE SHUTTLE VEHICLE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: NORED, D. L. TEL.

TECHNICAL SUMMARY

THIS EFFORT WILL PROVIDE CONCEPTUAL DESIGNS AND DATA TO ENHANCE CAPABILITY OF MAIN PROPULSION SYSTEMS TO ACHIEVE EXTENSIVE OPERATIONAL VERSATILITY AND HIGH PERFORMANCE REQUIRED FOR EARTH ORBIT LOGISTICS TYPE VEHICLES, SUCH AS THE REUSABLE SPACE SHUTTLE. EFFORT PERFORMED UNDER THIS RTOP WILL PROVIDE FOR INVESTIGATIONS OF NEW CONCEPTS AND TECHNIQUES THROUGH ANALYSIS, PRELIMINARY DESIGN AND SUBSCALE AND/OR FULL SCALE HARDWARE FEASIBILITY DEMONSTRATIONS. SEVEN TASKS ARE IDENTIFIED WHICH HAVE THE POTENTIAL CAPABILITY TO PROVIDE SHUTTLE MAIN PROPULSION TECHNOLOGY. SPECIFICALLY, THE TASKS OUTLINES IN THIS RTOP WILL: (1) DEMONSTRATE OPERATION OF A LOX-LH<sub>2</sub> ROCKET ENGINE USING SATURATED PROPELLANTS (2) DEVELOP THEORY AND PRACTICAL METHODS FOR DESIGN AND INSTALLATION OF COMBUSTION OSCILLATION DAMPING DEVICES FOR ROCKET COMBUSTION CHAMBERS (3) DEMONSTRATE SATURATED TANK LH<sub>2</sub> PUMPING FEASIBILITY (4) DEMONSTRATE AND VERIFY DESIGN CRITERIA FOR TWO PHASE OPERATION OF LIQUID HYDROGEN PUMP INDUCERS (5) INVESTIGATE THE CAUSES OF LOW FREQUENCY HIGH AMPLITUDE OSCILLATIONS IN HIGH SUCTION PERFORMANCE PUMPS AND DEFINE THEIR MECHANISM AND EVALUATE THEIR RESPONSE TO FEED SYSTEM COMPONENTS (6) INVESTIGATE STRESS AND HYDRODYNAMIC CHARACTERISTICS OF TITANIUM PUMP IMPELLERS FABRICATED BY THE DIFFUSION BONDING PROCESS (7) PROVIDE HANDBOOK TYPE DATA NECESSARY TO PREDICT FATIGUE LIFE OF BELLOWS FROM INVESTIGATION BY FLOW TESTING A NUMBER OF BELLOWS OF VARIOUS SIZES AND CONFIGURATIONS AT RESONANT CONDITIONS UNTIL FAILURE.

RTOP NO. 128-31-70 TITLE: FEED SYSTEMS AND ENGINE ACCESSORIES

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: GREGORY, J. W. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE IMPROVEMENTS IN THE TECHNOLOGY OF ROCKET ENGINE FEED SYSTEMS AND ENGINE ACCESSORIES. THE MAJOR PORTION OF THIS WORK WILL BE DEVOTED TO ADVANCEMENTS IN THE TURBO-MACHINERY AREA, AND WILL INCLUDE INVESTIGATION OF (1) SMALL CENTRIFUGAL AND POSITIVE DISPLACEMENT PUMPS, (2) HYDROGEN-OXYGEN FUELED TURBINES, (3) TURBOPUMP DYNAMICS AND (4) BEARINGS AND SEALS. THE PROGRAMS WILL BE DESIGNED TO FURTHER OUR KNOWLEDGE OF FLUID FLOW

PROCESSES AND PUMP PERFORMANCE LOSSES. THE PROGRAM OBJECTIVES WILL BE PURSUED LARGELY THROUGH PROGRAMS USING CRYOGENIC PROPELLANTS AND SPACE STORABLE PROPELLANTS. MUCH OF THE BASIC PUMP WORK WILL BE DONE WITH LIQUID HYDROGEN OR SIMULANT FLUIDS.

RTOP NO. 128-31-70 TITLE: FEED SYSTEMS AND ENGINE ACCESSORIES

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: WEEKS, P.

TEL. 213-354-2546

#### TECHNICAL SUMMARY

THE ADVANCED DEVELOPMENT EFFORTS WHICH SUPPORT THE OVERALL SR/AD PROGRAM FOR FEED SYSTEM AND ENGINE ACCESSORIES, RTOP NUMBER 128-31-70, ARE PRESENTED. THIS INCLUDES BOTH IN-HOUSE AND CONTRACT TASKS. THE WORK IS RELATED TO FOUR GENERIC TECHNOLOGY AREAS: (1) PRESSURIZED FEED SYSTEMS; (2) MATERIAL APPLICATION AND COMPONENT FABRICATION; (3) ENVIRONMENTAL EFFECTS ON MATERIALS; (4) COMPONENTS: VALVES AND CONTROLLERS. EMPHASIS IS BEING FOCUSED ON THE PROPELLANT COMBINATION OXYGEN DIFLUORIDE ( $OF_2$ ) AND DIBORANE ( $B_2H_6$ ); HOWEVER, EARTH STORABLES (I.E., NITROGEN TETROXIDE AND HYDRAZINE) ARE ALSO CONSIDERED FOR PERFORMANCE IMPROVEMENT PURPOSES. THE OBJECTIVE IS TO ADVANCE THE TECHNOLOGY OF CHEMICAL PROPULSION SYSTEMS FOR SPACECRAFT FOR FORESEEABLE SPACE AND PLANETARY NEAR AND LONG-TERM MISSIONS, AND TO FURNISH DATA UPON WHICH TO BASE PLANNING.

RTOP NO. 128-31-70 TITLE: FEED SYSTEMS AND ENGINE ACCESSORIES

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: WEEKS, P.

TEL. 205-453-1120

#### TECHNICAL SUMMARY

THE OBJECTIVE IS TECHNOLOGY ACQUISITION IN THE AREA OF LARGE TURBOPUMPS FOR ADVANCED LAUNCH VEHICLE SYSTEMS USING OXYGEN/HYDROGEN PROPELLANTS. THE SPECIFIC OBJECTIVE AREAS ARE: (1) CONTINUE INVESTIGATION OF THE STAGED INDUCER WHICH HAS SHOWN PROMISE AS A MEANS OF REDUCING THE PRESSURE INSTABILITIES WHICH ARE PRESENTLY ENCOUNTERED IN HIGH PERFORMANCE INDUCERS (2) THE ELIMINATION OF HIGH AMPLITUDE, LOW FREQUENCY PRESSURE OSCILLATIONS WHICH OCCUR IN HIGH SUCTION PERFORMANCE PUMPS AT CERTAIN COMBINATION OF PUMP NPSH AND FLOW COEFFICIENT (3) CONTINUE INVESTIGATION OF TITANIUM PUMP IMPELLERS, FABRICATED BY THE DIFFUSION BONDING PROCESS, WHICH HAVE DISCHARGE ANGLES OF 36 DEGREES AS COMPARED TO THE 60 DEGREES LIMIT OBTAINABLE WITH CURRENT MACHING TECHNIQUES IN ORDER TO OBTAIN INCREASED PUMP OPERATING STABILITY BECAUSE OF THE SMALLER DISCHARGE ANGLE (4) TO DEMONSTRATE FEASIBILITY OF SATURATED TANK  $LH_2$  PUMPING WITH THE S-IVB STAGE PROPELLANT FEED SYSTEM AND (5) DEVELOPMENT OF LUBRICATING OILS AND GREASES FOR USE IN CONTACT WITH LIQUID OXIDIZERS. THIS TECHNOLOGY WILL HAVE APPLICATION IN FUTURE NASA PROGRAMS SUCH AS THE ILRV (SHUTTLE) AND LARGE LOGISTIC VEHICLES.



RTOP NO. 128-31-70 TITLE: FEED SYSTEM AND ENGINE ACCESSORIES  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: YODZIS, C. TEL. 713-483-4924  
TECHNICAL SUMMARY

THE WORK IN THIS RTOP DURING FY 70 SHALL BE DIRECTED TO THE REFINEMENT IN THE TECHNOLOGY FOR PRESSURE-FED EARTH STORABLE SYSTEMS, INCLUDING COMPATIBILITY STUDIES, TRANSIENT EFFECTS, AND FEED SYSTEM DYNAMIC MODELING, ALL OF WHICH ARE ON-GOING EFFORTS. ADDITIONAL EFFORTS TO BE CONSIDERED DURING FY 70 INCLUDE CRYOGENIC FEED SYSTEMS TECHNOLOGY SUPPORT FOR THE SHUTTLE VEHICLE AND SPACE STATION.

RTOP NO. 128-31-76 TITLE: LIQUID ROCKET THRUST CHAMBER AND INJECTOR DESIGN  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: YODZIS, C. TEL. 713-483-4924  
TECHNICAL SUMMARY

THE RELATIVELY LONG EXTENDED MISSIONS OF THE FUTURE MANNED SPACECRAFT REQUIRE DEVELOPMENT OF SAFE AND HIGHLY RELIABLE PROPULSION SUBSYSTEMS WHICH MEET A NEW BROAD SET OF REQUIREMENTS AND MINIMIZE POTENTIAL FAILURES OR HAZARDS. UNDER THIS WORK A BROAD BASE OF WORK IS CONTEMPLATED: WORK WILL BE CONTINUED WITH THE HYDRAZINE FAMILY OF FUELS AND NITROGEN TETROXIDE TO INCREASE CONFIDENCE AND TECHNOLOGICAL SOPHISTICATION. ALSO, INVESTIGATIONS IN THE HALOGEN FAMILY OXIDIZERS AND CRYO PROPELLANTS IN ORDER TO ESTABLISH BASELINES FOR FUTURE MISSIONS. SPECIFIC AREAS FOR ADVANCED LIQUID PROPULSION SYSTEMS INVESTIGATION ARE: (A) INJECTOR AND THROTTLING CONCEPTS FOR GAS-LIQUID, AND MIXED PHASE INJECTION, (B) INJECTOR TECHNOLOGY, (C) IMPROVED THEORETICAL METHODS AND COMPUTER TECHNIQUES, AND (D) NOZZLE TECHNOLOGY.

RTOP NO. 128-31-76 TITLE: THE LIQUID ROCKET THRUST CHAMBER AND INJECTOR DESIGN  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: YODZIS, C. TEL. 205-453-1120  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO GENERATE INJECTOR AND THRUST CHAMBER DESIGN PARAMETERS FOR LIQUID ROCKET ENGINES USING OXYGEN AND NITROGEN AS PROPELLANTS; LAUNCH VEHICLES APPLICATION AND SPACECRAFT APPLICATION WHERE THRUST GREATER THAN 50,000 POUNDS IS REQUIRED; DESIGNS THAT WILL BE ADAPTABLE TO SCALING BY REPLICATION; AND WITH THE GUIDELINE OF DEVELOPING MORE THAN 97 P EFFICIENTLY. THESE OBJECTIVESERCENT C SHALL BE FULFILLED IN TERMS OF QUANTATIVE KNOWLEDGE OF THE INDIVIDUAL PROCESSES IN THE COMBUSTION CHAMBER WHICH CAUSE LOSSES FROM RESULTING IN LESS THAN 100 PERCENT EFFICIENCY. A BETTER UNDERSTANDING AND SOLUTION OF PROBLEMS IN THIS CHEMICAL PROPULSION AREA WOULD GIVE A SUBSTANTIAL ADVANCEMENT WHICH COULD BE UTILIZED ON FUTURE NASA PROJECTS.

RTOP NO. 128-31-76 TITLE: LIQUID ROCKET THRUST CHAMBER AND INJECTOR  
DESIGN

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MEERKS, P. TEL. 213-354-2546

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO GENERATE INJECTOR AND THRUST CHAMBER DESIGN CRITERIA AND A TECHNOLOGY BASE FOR LIQUID ROCKET SPACECRAFT ENGINES IN THE 200 TO 5000-LB-THRUST CLASS USING THE SPACE-STORABLE PROPELLANT COMBINATION OF  $OF_2/B_2H_6$ . THE GOAL IS AN ENGINE CONCEPT WHICH IS CAPABLE OF MULTIPLE RESTARTS, UNLIMITED DURATION, SIMPLIFIED DESIGN, AND HIGH PERFORMANCE. THIS WILL BE ACCOMPLISHED THROUGH A COORDINATED PROGRAM WHICH GENERATES OPTIMIZATION PARAMETER WHILE PRODUCING DESIGN INFORMATION ON PERFORMANCE, STABILITY, HEAT FLUX, COMPATIBILITY, GEOMETRIC EFFECTS, AND SUITABILITY OF VARIOUS COOLING TECHNIQUES. PASSIVELY-COOLED CARBONACEOUS AND GRAPHITIC CHAMBERS WILL BE EVALUATED AS WELL AS MORE COMPLEX COOLING TECHNIQUES INCLUDING CONDUCTION COOLING, REGENERATIVE COOLING, AND HEAT PIPES. REDUCTION OF HEAT FLUX WILL BE ACTIVELY PURSUED THROUGH THE USE OF TECHNIQUES SUCH AS MIXTURE RATIO GRADIENTS AT THE WALL AND FILM COOLING. COOLING EFFECTS ON PERFORMANCE WILL BE STUDIED.

RTOP NO. 128-31-80 TITLE: PROPELLANT PROPERTIES AND PERFORMANCE

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: MEERKS, P. TEL. 213-354-2546

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO OBTAIN INFORMATION ON THE PERTINENT PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED ROCKET PROPELLANTS. AT JPL THIS WORK IS DIRECTED TO ADVANCING THE STATE-OF-THE-ART THROUGH: A. CONTINUING RESEARCH IN FLUID FLOW STOPPAGE PHENOMENA PECULIAR TO THE STATED PROPELLANTS; B. PREPARING TO TEST AN ENGINE SYSTEM USING GELLED  $OF_2$  AND  $B_2H_6$  AND COMPARING SYSTEM PERFORMANCE PARAMETERS TO THE SAME SYSTEM USING NEAT PROPELLANTS. THE LONG-RANGE GOALS OF THIS RESEARCH AND TECHNOLOGY EFFORT ARE TO PROVIDE A STRONG TECHNOLOGY BASE IN  $OF_2-B_2H_6$  AND SOME EARTH STORABLE PROPELLANTS FOR THE EXPERIMENTAL ENGINEERING PROGRAM AND APPLICATION BY OSSA TO ADVANCED PLANETARY MISSIONS.

RTOP NO. 128-31-80 TITLE: PROPELLANT PROPERTIES AND PERFORMANCE

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: MEERKS, P. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO ACHIEVE IMPROVED PERFORMANCE OF CHEMICAL PROPULSION SYSTEMS FROM SELECTED PROPELLANTS AND TO OBTAIN INFORMATION ON THE PERTINENT PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED PROPELLANTS. MISSION ANALYSES SHOW THE INCREASED HEAT CAPACITY OF SUBCOOLED OR SLUSH PROPELLANTS TO REDUCE IN-FLIGHT VENTING AND INCREASE PAYLOAD POTENTIAL. THE FEASIBILITY OF MANUFACTURING, STORING, TRANSFERRING AND UPGRADING THE SOLID FRACTION HAS BEEN DEMONSTRATED BY LABORATORY AND SUBSCALE TESTING.

QUANTITATIVE RESULTS OF THESE EXPERIMENTAL SLUSH HYDROGEN STUDIES TO DATE HAVE BEEN MISLEADING DUE TO INADEQUATE SLUSH QUALITY AND QUANTITY MEASUREMENTS. ADVANCES IN THE STATE-OF-THE-ART OF MEASUREMENT SYSTEMS, I.E., CAPACITANCE, NUCLEAR ATTENUATION (GAMMA AND BETA), MICROWAVE PHASE SHIFT AND LASER LIGHT SCATTER, HAVE BEEN EVALUATED IN THE LABORATORY AND THE SLUSH QUALITY REFERENCE SYSTEM OFFERS GOOD POTENTIAL. IT IS PLANNED TO ADAPT TO FIELD OPERATION ONE OR MORE OF THE QUALITY MEASUREMENT SYSTEMS DEVELOPED AND DEMONSTRATED IN THE LABORATORY. THE RESULTANT INSTRUMENTATION WILL BE USED AS TRANSFER STANDARD AND QUALITY INSTRUMENTATION TO ESTABLISH PERFORMANCE CHARACTERISTICS IN DEVELOPMENT PROGRAMS. HEAT AND MASS TRANSFER PROCESSES ARE THE PRIMARY PARAMETERS IN DETERMINING THERMAL ENERGY DISTRIBUTION IN CRYOGENS. THE LOCATION OF THE INCIPIENT BOILING POINT AT REDUCED GRAVITY IS ESSENTIAL FOR PROPER DESIGN OF THERMODYNAMIC SEPARATORS, VENT AND DESTRATIFICATION DEVICES FOR SPACE MISSIONS. ADVANCED PROPULSION SYSTEM REQUIREMENTS WILL BE IDENTIFIED AND TECHNOLOGY PROGRAMS DELINEATED.

RTOP NO. 128-31-80 TITLE: PROPELLANT PROPERTIES AND PERFORMANCE  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: YODZIS, C. TEL. 713-483-4924  
TECHNICAL SUMMARY

WORK UNDER THIS RTOP DURING FY 70 IS DIRECTED TO THE BETTER UNDERSTANDING OF THE INJECTION, COMBUSTION AND NOZZLE FLOW PROCESSES TO ALLOW ACCURATE PREDICTION OF PERFORMANCE OVER THE FULL RANGE OF OPERATING SYSTEM, AND ENVIRONMENTAL VARIABLES. INCLUDED ARE THE MULTI-ZONE ANALYSIS OF COMBUSTION PROCESSES AND THE EFFECTS OF INJECTION INEFFICIENCIES AND INHOMOGENEITIES IN H/O ENGINES.

RTOP NO. 128-31-90 TITLE: COMBUSTION AND IGNITION  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: YODZIS, C. TEL. 713-483-4924  
TECHNICAL SUMMARY

WORK UNDER THIS RTOP SHALL ESTABLISH BASIC DESIGN INFORMATION NECESSARY TO ASSURE STABLE COMBUSTION AND RELIABLE IGNITION FOR THE CLASS OF ENGINES OF INTEREST AT MANNED SPACECRAFT CENTER. ON-GOING WORK WILL BE CONTINUED TO COMPLETION ON THE CURRENT EARTH STORABLE ENGINE SYSTEMS. NEW EFFORTS SHALL BE DEVELOPED TO ESTABLISH A TECHNOLOGY AND DESIGN BASE FOR FUTURE CRYOGENIC ENGINE REQUIREMENTS DEVELOPING IN THE SHUTTLE AND SPACE STATION.

RTOP NO. 128-31-90 TITLE: COMBUSTION AND IGNITION  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: PRIEM, R. J. TEL. 216-433-4000  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PROVIDE NEW TECHNOLOGY IN THE AREA OF COMBUSTION AND IGNITION PHENOMENA IN LIQUID ROCKETS, WHICH CAN BE USED IN FUTURE SPACE AND LAUNCH VEHICLE ENGINES TO OBTAIN

IMPROVED RELIABILITY (STABLE COMBUSTION, CONTROLLED IGNITION AND RESTART, NO COMBUSTION CHAMBER HOT SPOTS), HIGH PERFORMANCE, AND REDUCE DEVELOPMENT COSTS. THESE OBJECTIVES WILL BE ATTAINED THROUGH:

1) THEORETICAL STUDIES TO DELINEATE THE IMPORTANT DESIGN PARAMETERS FOR ACHIEVING HIGH PERFORMANCE AND RELIABILITY, 2) EXPERIMENTAL STUDIES TO YIELD QUANTITATIVE KNOWLEDGE TO DEMONSTRATE THE VALIDITY OF SPECIFIC THEORETICAL APPROACHES AND/OR DESIGN PARAMETERS, AND 3) EXPLORATORY STUDIES TO INVESTIGATE NEW TECHNIQUES OR THEORETICAL APPROACHES THAT WILL AID IN OBTAINING HIGH PERFORMANCE AND RELIABILITY.

RTOP NO. 128-31-90 TITLE: COMBUSTION AND IGNITION

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: WEEKS, J.

TEL. 213-354-2546

TECHNICAL SUMMARY

EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF THE COMBUSTION PROCESSES IN A LIQUID PROPELLANT ROCKET ENGINE ARE BEING CONDUCTED IN ORDER TO PROVIDE DESIGN CRITERIA REQUIRED FOR THE APRIORI SPECIFICATION OF STABLE, RELIABLE, AND HIGH PERFORMANCE ROCKET ENGINES UTILIZING HIGH ENERGY LIQUID PROPELLANTS. THIS INFORMATION WILL BE USED IN WORK UNDER THE RTOP, ENTITLED "LIQUID ROCKET THRUST CHAMBER AND INJECTOR DESIGN" (128-31-76), BY THE 731 PROGRAM ADVANCED EXPERIMENTAL ENGINES AND BY USER AGENCIES SUCH AS OMSF AND OSSA TO IMPROVE THEIR ENGINES. THE JPL PROGRAM ON COMBUSTION INSTABILITY WILL BE DISTINGUISHED FROM THAT OF OTHER AGENCIES BY THE EMPHASIS ON THE DETONATION-LIKE CHARACTERISTICS OF TRANSITION TO AND SUSTENANCE OF THE DESTRUCTIVE RESONANT COMBUSTION MODE. MEANS FOR INHIBITING AND CONTROLLING SUCH DISTURBANCES WILL BE SOUGHT.

RTOP NO. 128-31-90 TITLE: COMBUSTION AND IGNITION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: WEEKS, J.

TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO FURNISH THE BASIC COMBUSTION AND IGNITION PHENOMENA INFORMATION TO FACILITATE ACHIEVING DYNAMICALLY STABLE OPERATION IN HIGH PERFORMANCE LIQUID ROCKET COMBUSTION CHAMBERS, ESPECIALLY THOSE USING HYDROGEN-OXYGEN AS PROPELLANTS. THIS INFORMATION IS REQUIRED FOR THE EXPERIMENTAL ROCKET ENGINEERING, CODE 731 AND OMSF SUPPORTING DEVELOPMENT PROGRAMS, CODE 908. THE TECHNOLOGY DEVELOPED WILL BE APPLICABLE TO LARGE ENGINES (GREATER THAN 50,000 LBS.) SUCH AS ILRV, SPACECRAFT, AND LARGE EXPENDIBLE LOGISTIC VEHICLE. THE RESEARCH TO BE UNDERTAKEN BOTH IN-HOUSE AND BY CONTRACTOR WILL INCLUDE ANALYTICAL STUDIES, MATHMODELS, THEORETICAL STUDIES, TO IMPROVE ANALYSIS OF REACTING FLOW FIELDS, ACCURATE DESCRIPTION OF THE MIXING AND COMBUSTION PROCESS OCCURRING IN ROCKET PROPULSION SYSTEMS, AND TESTING OF STABILITY DAMPING DEVICES AND COMBUSTERS.

RTOP NO. 128-31-95 TITLE: HEAT TRANSFER AND FLUID FLOW PROCESSES  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: MEEKS, J. TEL. 205-453-1120  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO BROADEN THE RANGE OF ENGINE SPECIFICATIONS BY IMPROVEMENTS IN HEAT TRANSFER AND FLUID FLOW, ESPECIALLY FLOW IN ROCKET NOZZLES, IN ORDER TO DESIGN ROCKET THRUST CHAMBER OF ENHANCED PERFORMANCE CAPABILITY, LIGHTER WEIGHT, AND IMPROVED RELIABILITY. THE TECHNOLOGY WILL BE APPLICABLE TO THE CODE 731 EXPERIMENTAL ENGINE PROGRAM. THE AREAS OF INTEREST ARE: (1) MINIMUM PRESSURE LOSS IN HIGH VELOCITY FLOW DUST SYSTEMS (2) TRANSPIRATION COOLING LIQUID ROCKET THRUST CHAMBERS (3) CHARACTERISTICS OF SEPARATED FLOW REGIMES WITHIN ALTITUDE COMPENSATING NOZZLE.

RTOP NO. 128-31-95 TITLE: HEAT TRANSFER AND FLUID FLOW PROCESSES  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: MEEKS, P. TEL. 213-354-2546  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO ADVANCE THE STATE OF THE ART OF HEAT TRANSFER AND FLUID FLOW; SPECIFICALLY FLOW IN AND BEYOND ROCKET MOTOR NOZZLES. THE GOAL IS TO ENHANCE THE CAPABILITY OF LIQUID ROCKET MOTOR NOZZLES AND REDUCE HEAT FLUX THROUGH THE USE OF RADICAL NOZZLE SHAPES. TO ACHIEVE THIS GOAL, A BETTER UNDERSTANDING OF THE SUBSONIC AND SUPERSONIC FLOW FIELDS, AND THEIR INTERACTION, MUST BE DEVELOPED. A BETTER QUANTITATIVE KNOWLEDGE OF BOUNDARY LAYER PHENOMENA IN NOZZLES MUST ALSO BE DEVELOPED IN ORDER TO PREDICT THE SPECIAL LOCATION OF THE BOUNDARY LAYER AFTER IT LEAVES THE NOZZLE. THE RADICAL NOZZLE APPROACH OFFERS THE POSSIBILITY OF DRASTICALLY REDUCED HEAT TRANSFER LOADS TO ROCKET ENGINE THRUST CHAMBERS AND THEREBY PERMITS THE USE OF SIMPLIFIED COOLING TECHNIQUES FOR HIGH ENERGY SPACE STORABLE PROPELLANT SYSTEMS. THESE SAME ANALYTICAL TECHNIQUES COULD BE EXTENDED TO COVER INTERACTION OF EXHAUST JETS WITH EXTERNAL FLOW AND BODY SHAPES.

RTOP NO. 128-31-95 TITLE: HEAT TRANSFER AND FLUID FLOW PROCESSES  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: WHITCOMB, R. T. TEL. 703-827-2252  
TECHNICAL SUMMARY

A ROCKET EXHAUSTING INTO EITHER A MOVING OR A QUIESCENT ATMOSPHERE CAUSES, THROUGH VISCOUS INTERACTION, SUBSTANTIAL CHANGES IN THE BASIC STRUCTURES OF THE SURROUNDING FLOW FIELD. MEASUREMENTS, INCLUDING FORCES, MOMENTS, PRESSURES, AND FLOW FIELD SCHLIEREN PHOTOGRAPHS, ARE BEING OBTAINED FOR SIMULATED EXHAUST FLOW IN ORDER TO IDENTIFY THE BASIC CHARACTER OF THE INTERACTIONS AND TO PROVIDE A SOUND BASIS FOR THEORETICAL ANALYSIS. PROPULSIVE, ATTITUDE CONTROL, AND RETRO-NOZZLE FLOWS ARE BEING INVESTIGATED. IDENTIFICATION OF NON-STEADY AS WELL AS STEADY FLOW INTERACTIONS ARE SOUGHT.

RTOP NO. 128-31-95 TITLE: HEAT TRANSFER AND FLUID FLOW  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: GREGORY, J. W. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROGRAM ARE TO PROVIDE IMPROVEMENTS IN THE TECHNOLOGY AND INCREASED UNDERSTANDING OF HEAT TRANSFER AND FLUID FLOW PROCESSES IN LIQUID ROCKET THRUST CHAMBERS. RELIABILITY, WEIGHT, AND PERFORMANCE ARE AREAS SUBJECT TO IMPROVEMENT IN BOTH CURRENT AND FUTURE ROCKET ENGINES THROUGH A BETTER UNDERSTANDING OF SUCH PROCESSES. IN THE HEAT TRANSFER AREA, EFFORTS WILL BE DIRECTED TOWARD IMPROVING OUR ABILITY TO COOL ROCKET ENGINES IN HIGH HEAT FLUX SITUATIONS (E.G., ENGINES USING SPACE STORABLE PROPELLANTS, HYDROGEN-FLUORINE, OR HIGH PRESSURE HYDROGEN-OXYGEN), OR UNDER SPECIAL HEAT TRANSFER SITUATIONS. TRANSPIRATION, FILM, AND FORCED CONVECTIVE COOLING ARE THE PRIMARY TECHNIQUES OF INTEREST. IN THE FLUID FLOW AREA, EXPERIMENTAL AND ANALYTICAL EFFORTS WILL INCLUDE EVALUATION OF EFFECTS ON NOZZLE PERFORMANCE OF CHEMICAL DISSOCIATION PECULIAR TO HIGH ENERGY, HIGH TEMPERATURE PROPELLANTS, AND EFFECTS ON NOZZLE PERFORMANCE OF PARTICLE CONDENSATION AND DRAG ASSOCIATED WITH THE VERY HIGH ENERGY TRIPROPELLANT SYSTEMS. WORK WILL ALSO BE CONDUCTED ON IMPROVED TECHNIQUES FOR CRYOGENIC FLUID FLOW MEASUREMENT AND DYNAMIC ROCKET DATA ANALYSIS.

RTOP NO. 128-32-60 TITLE: CHEMICAL PROPULSION SYSTEMS  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

CONCEIVE NEW AND IMPROVE EXISTING SOLID PROPULSION SYSTEMS SO THAT THEY CAN MEET THE SPACECRAFT REQUIREMENTS FOR FUTURE NASA MISSIONS. WORK WILL BE CONDUCTED TO OBTAIN A COMPARISON OF THE PERFORMANCE AND ATTRIBUTES OF SEVERAL POTENTIAL CONTROLLABLE SOLID ROCKET SYSTEMS. EXPERIMENTAL WORK IS TO BE CONDUCTED IN-HOUSE TO DETERMINE THE CHARACTERISTICS OF THE WATER QUENCH TECHNIQUE. AN EXPERIMENTAL EVALUATION OF A HYBRID OR SOLID SYSTEM WILL BE CONDUCTED BY AN INDUSTRIAL CONTRACTOR. THIS EFFORT WILL BE DIRECTED TOWARD THE MISSION REQUIREMENTS FOR OUTER PLANETARY EXPLORATION BY ORBITING SPACECRAFT.

RTOP NO. 128-32-60 TITLE: SOLID PROPULSION SYSTEMS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: SWAIN, R. L. TEL. 703-827-2888

TECHNICAL SUMMARY

THE OVERALL OBJECTIVE OF THIS PROGRAM IS TO DETERMINE THE HIGH PERFORMANCE POTENTIAL OF SOLID OR SOLID-DERIVED (HYBRID, TRIBRID) ROCKET PROPULSION SYSTEMS AS CANDIDATES TO ACCOMPLISH PROPULSION FUNCTIONS REQUIRED FOR FUTURE NASA MISSIONS. A PARTICULAR OBJECTIVE THROUGH FY 72 IS TO DEMONSTRATE AND EVALUATE THE TRIBRID ROCKET PROPULSION CONCEPT, PRIMARILY THROUGH ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF LITHIUM/FLUORINE/HYDROGEN PROPELLANT SYSTEMS. RESULTS OF THIS CONCEPT EVALUATION WILL DETERMINE WHETHER FURTHER



TECHNOLOGY DEVELOPMENT OF FULL-SCALE TRIBRID ROCKET COMPONENTS WILL BE PURSUED AFTER FY 72. CONTRACTED EXPERIMENTAL PROGRAMS AND STUDIES SINCE 1964 HAVE SHOWN THAT HIGH ENERGY HYBRID ROCKET SYSTEMS ARE TECHNICALLY FEASIBLE FOR UPPER STAGE APPLICATIONS, WILL PERFORM AS WELL AS COMPETITIVE "SPACE STORABLE" LIQUID SYSTEMS NOW UNDER INVESTIGATION, AND CAN BE DEVELOPED AT A SIGNIFICANTLY LOWER COST. THE TRIBRID ROCKET PROPULSION SYSTEM EXTENDS HYBRID TECHNOLOGY BY ADDING LIQUID HYDROGEN AS A WORKING FLUID, WITH APPROXIMATELY 16% HIGHER SPECIFIC IMPULSE AND A COMBUSTION TEMPERATURE OF 3000 DEGREES F COMPARED TO 8500 DEGREES F (WHICH MAY LIMIT LONG-TIME NOZZLE OPERATION OF HIGH PERFORMANCE HYBRIDS). TWO DIFFERENT TECHNICAL APPROACHES TOWARD DEMONSTRATING THE PERFORMANCE POTENTIAL OF TRIBRIDS WHILE MINIMIZING HYDROGEN TANKAGE WEIGHT WILL BE FOLLOWED IN SEPARATE CONTRACTED EFFORTS. BOTH WILL DETERMINE DELIVERED IMPULSE PERFORMANCE AND COMBUSTION EFFICIENCY FOR SUBSCALE MOTORS UTILIZING PROPELLANT GRAINS WITH VARIOUS FUEL AND BINDER COMBINATIONS; ONE APPROACH WILL UTILIZE HYDROCARBON BINDERS, THE OTHER A METALLIC BINDER. LIMITED IN-HOUSE SUPPORT WILL BE PROVIDED IN THE AREA OF COMBUSTION PROCESS HEAT TRANSFER ANALYSIS. AT THE COMPLETION OF THE TRIBRID CONCEPT EVALUATION, THOSE AREAS OF TRIBRID TECHNOLOGY WHICH REQUIRE ANALYTICAL AND EXPERIMENTAL CHARACTERIZATION WILL HAVE BEEN RESEARCHED TO THE EXTENT NECESSARY TO PROVIDE A REALISTIC ASSESSMENT OF OVERALL TRIBRID CAPABILITY.

RTOP NO. 128-32-70 TITLE: COMPONENTS, MATERIALS AND SUBSYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: SWAIN, R. L. TEL. 703-827-2888

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP AND DEMONSTRATE COMPONENTS, MATERIALS AND SUBSYSTEMS FOR ADVANCED SOLID AND HYBRID ROCKET SYSTEMS WITH A VIEW TOWARD RELIABILITY, COST EFFECTIVENESS, AND PERFORMANCE THROUGH USE OF IMPROVED MATERIALS AND CONCEPTS. SATISFACTORY NOZZLE SYSTEMS FOR ACCOMMODATING COMBUSTION TEMPERATURES TO 9000 DEGREES F AT HIGH PRESSURES DO NOT CURRENTLY EXIST AND MUST BE DEVELOPED IF ADVANCED HIGHLY ENERGETIC SOLIDS AND HYBRIDS ARE TO BE USED. IMPROVED NONDESTRUCTIVE TESTING TECHNIQUES ARE REQUIRED TO LOCATE AND DEFINE CRITICAL FLAWS IN PROPULSION SYSTEM COMPONENTS. BOTH IN-HOUSE AND CONTRACTED STUDIES WILL EXPLORE SOLUTIONS TO THESE PROBLEM AREAS. THE NOZZLE INVESTIGATIONS WILL CENTER PRIMARILY ON SURVIVABILITY THROUGH ACTIVE COOLING TECHNIQUES - MASS INJECTION INTO THE BOUNDARY LAYER. SEVERAL PROMISING CONCEPTS WILL BE EVALUATED. DEMONSTRATION OF A NOZZLE SUITABLE FOR HYBRID ROCKET APPLICATIONS BY FY 1972 IS ANTICIPATED. ADVANCED NOZZLES FOR FOLLOW-ON SYSTEMS EMPLOYING MORE ENERGETIC PROPELLANTS WILL BE STUDIED.

RTOP NO. 128-32-70 TITLE: COMPONENTS, MATERIALS AND SUBSYSTEMS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137

TECHNICAL SUMMARY

THE LONG-RANGE OBJECTIVES OF THIS WORK ARE TO EVALUATE NEW AND

PROMISING MATERIALS FOR POSSIBLE APPLICATION IN SOLID-PROPELLANT MOTOR COMPONENTS, SUCH AS, NOZZLES, CHAMBER INSULATION AND TVC SYSTEMS. FABRICATION TECHNIQUES AND COMPONENT DESIGN, USING THE MORE PROMISING MATERIALS, WILL BE EVALUATED WITH RESPECT TO INTERFACES AND ENVIRONMENTS PECULIAR TO SPACECRAFT APPLICATIONS. PROBLEMS OF COMPONENTS AND MATERIALS ASSOCIATED WITH LONG BURNING TIME (300 SEC.) MOTORS WILL BE STUDIED. NOZZLE AND INSULATION MATERIALS OF INTEREST WILL BE INITIALLY EVALUATED ON JPL DESIGNED NON-GELLING SOLID PROPELLANT TEST MOTORS WHICH HAVE VARIABLE MOTOR PARAMETERS. LIGHT WEIGHT (SPECIFIC GRAVITY LESS THAN 1.0) AND ADVANCED NOZZLE MATERIALS WILL BE EVALUATED, WITH RESPECT TO EROSION AND THRUST MISALIGNMENT, ON THE MULTI-COMPONENT TEST STAND. THE NON-GELLING SOLID-PROPELLANT TEST MOTORS (UTM-12 & 48) HAVE BEEN SUCCESSFULLY USED TO EVALUATE NOZZLE AND INSULATION MATERIALS. A MULTI-COMPONENT TEST STAND HAS BEEN OBTAINED, ACCEPTANCE TESTED, AND ACCEPTED FOR USE. CANDIDATE NOZZLE MATERIALS FOR LONG BURNING TIME APPLICATION, SUCH AS CARBITEX AND FIBERGRAPH, HAVE BEEN INITIALLY EVALUATED FOR USE IN FLIGHT-WEIGHT DESIGNS.

RTOP NO. 128-32-80 TITLE: SOLID PROPELLANT DEVELOPMENT  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137  
TECHNICAL SUMMARY

THE TWO CHIEF OBJECTIVES OF THIS PLAN ARE (1) TO EXTEND THE CAPABILITIES OF SOLID PROPELLANTS TO MEET REQUIREMENTS OF FUTURE SPACECRAFT MISSIONS, WHOSE DEMANDS ARE GROWING EVER MORE SEVERE, AND (2) TO DEVELOP THE TOOLS WITH WHICH TO PREDICT THE MECHANICAL PERFORMANCE OF SOLID PROPELLANTS AS INTEGRATED STRUCTURAL COMPONENTS OF HIGH-PERFORMANCE SPACECRAFT MOTORS, IN ORDER TO PRODUCE MORE EFFICIENT DESIGNS AND REDUCE THE COST OF MOTOR DEVELOPMENT. PROPELLANT IMPROVEMENTS ARE BEING SOUGHT IN PERFORMANCE AND IN WIDER RANGES OF ENVIRONMENTAL STABILITY. WORK IN THESE AREAS INCLUDE DEVELOPMENTS OF MATERIALS AND PROCESSES TO EXPLOIT THE ENERGETIC FUEL, BERYLLIUM HYDRIDE AND THE OXIDIZER, HYDROXYLAMMONIUM PERCHLORATE. IT IS BEING SUPPORTED BY DEVELOPMENTS OF NEW BINDERS, CHEMICALLY RUGGED AND ENERGETIC, AND BY FUNDAMENTAL STUDIES OF POLYMER NETWORK THEORY. THE WORK IN MECHANICAL BEHAVIOR IS AIMED AT PROVIDING A FULL KNOWLEDGE AND SET OF METHODS WHICH WILL ALLOW THE DESIGN OF A ROCKET MOTOR THROUGH THE APPLICATION OF STRESS ANALYSIS ALONG WITH MATERIAL CHARACTERISTICS. IT IS SUPPORTED BY VISCOELASTIC THEORY OF FILLED SYSTEMS DEVELOPMENT, STUDIES OF FAILURE MODES, AND STUDIES OF DEGRADATION MECHANISMS.

RTOP NO. 128-32-90 TITLE: SOLID PROPULSION COMBUSTION AND KINETICS  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137  
TECHNICAL SUMMARY

THIS PROGRAM IS A BROAD BASED APPLIED RESEARCH PROGRAM TO INVESTIGATE AND PROVIDE NEW KNOWLEDGE ABOUT SEVERAL OF THE COMPLEX PROCESSES WHICH OCCUR DURING THE MANUFACTURE, STORAGE, AND FIRING OF

SOLID PROPELLANT ROCKET MOTORS. WORK IS BEING CONDUCTED IN IGNITION, COMBUSTION, AND COMBUSTION INSTABILITY OF SOLID PROPELLANTS. THE WORK IS FOCUSED ON THOSE PROBLEMS ASSOCIATED WITH MOTORS FOR FUTURE NASA OUTER PLANETARY EXPLORATION MISSIONS. THE WORK IS TO BE CONDUCTED THROUGH IN-HOUSE AND CONTRACTED EFFORTS BY INDUSTRIAL, ACADEMIC, AND GOVERNMENT RESEARCH PERSONNEL.

RTOP NO. 128-32-90 TITLE: SOLID PROPULSION COMBUSTION AND KINETICS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: SWAIN, R. L. TEL. 703-827-2888  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IN SOLID PROPULSION COMBUSTION AND KINETICS IS TO ACQUIRE PERTINENT EXPERIMENTAL KNOWLEDGE AND UNDERSTANDING OF (1) CONDENSED-PHASE REACTION AND GASIFICATION MECHANISMS OF AMMONIUM PERCHLORATE-BASED COMPOSITE PROPELLANTS, (2) DOMINANT GAS-PHASE REACTION AND HEAT/MASS TRANSFER MECHANISMS JUST ABOVE BURNING PROPELLANT SURFACES, AND (3) THE GASDYNAMICS AND BALLISTICS OF CERTAIN ROCKET CHAMBERS. SPECIFIC CONTRACTED AND IN-HOUSE PROGRAM PLANS COVER RESEARCH IN THE FOLLOWING AREAS: EFFECTS OF CONDENSED-PHASE REACTIONS ON PROPELLANT COMBUSTION, CO<sub>2</sub> LASER PYROLYSIS - MASS SPECTROMETRY OF PROPELLANT INGREDIENTS, AMMONIUM PERCHLORATE STABILIZATION, PROPELLANT FLAME MICROSTRUCTURE DETERMINATIONS, PERCHLORIC ACID FLAME STUDIES, METAL COMBUSTION, ACCELERATION-INDUCED PROPELLANT COMBUSTION EFFECTS, EFFECTS OF PROPELLANT STRAIN ON COMBUSTION, DEPRESSURIZATION EXTINCTION OF SOLID PROPELLANTS, WATER-QUENCH EXTINCTION, AND COMBUSTION INSTABILITY.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO ACQUIRE AN UNDERSTANDING OF THE BASIC FLUID DYNAMIC MECHANISMS AND CONTROLLING PHYSICAL PARAMETERS IN PROBLEMS RELEVANT TO AERONAUTICS. SPECIFICALLY, THIS WORK WILL COVER (A) HYPERSONIC TURBULENT BOUNDARY LAYERS (HEAT TRANSFER, TRANSITION, SEPARATION, MASS ADDITION), (B) THE ATMOSPHERIC ENVIRONMENT SUCH AS STORMS, TORNADOS, CLEAR AIR TURBULENCE, (C) FLUID MECHANICS PROBLEMS PERTINENT TO AERONAUTICS SUCH AS SONIC BOOM, AND THE SOURCE AND CONTROL OF AERODYNAMIC NOISE AND (D) AIRCRAFT HAZARDS SUCH AS FIRE. THIS WORK WILL BE UNDERTAKEN THROUGH A COMBINATION OF PHYSICAL SIMULATION (WIND TUNNEL TESTING), ANALYTICAL SIMULATION (COMPUTER SOLUTIONS), AND THEORETICAL ANALYSIS. RESULTS WILL BE APPLICABLE TO ADVANCED AERONAUTICAL SYSTEMS AND PROVIDE NECESSARY INPUTS FOR DEVELOPING IMPROVED AIRCRAFT.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THIS EFFORT WILL GIVE AN UNDERSTANDING OF BASIC FLUID DYNAMIC MECHANISMS AND CONTROLLING PHYSICAL PARAMETERS IN BASIC PROBLEMS RELEVANT TO AERODYNAMICS. BOTH THEORETICAL AND EXPERIMENTAL STUDIES ARE EMPLOYED AND THE EFFORT FOR THE PRESENT FISCAL YEAR CAN BE CHARACTERIZED BY THE FOLLOWING ACTIVITIES. STUDIES OF SEPARATION AND THREE-DIMENSIONAL BOUNDARY LAYER FLOWS, TURBULENT BOUNDARY LAYERS MASS TRANSFER EFFECTS ON BOUNDARY LAYER FLOWS, BOUNDARY LAYER TRANSITION, THE EFFECT OF SECONDARY JET INJECTION, THE PREDICTION OF FLOW FIELDS ABOUT CONFIGURATIONS, SONIC BOOM PROPAGATION IN THE ATMOSPHERE, AND HYPERSONIC WIND TUNNEL DEVELOPMENT.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 205-453-1120  
TECHNICAL SUMMARY

CURRENT AND FUTURE SPACE VEHICLES ARE AND WILL BE PLAGUED BY CRITICAL, CRUDE, COSTLY AND OVERLY CONSERVATIVE ENGINEERING ESTIMATES OF UNSTEADY FLUID DYNAMICS, NATURAL AND SELF INDUCED ADVERSE ENVIRONMENTS. THESE ENVIRONMENTS (WIND-INDUCED OSCILLATIONS, NOISE GENERATED BY JET OR ROCKET EXHAUSTS, THE UNSTEADY FLOW OF AIR OVER THE VEHICLE SURFACE AND AROUND PROTUBERANCES DURING FLIGHT, ETC.) ARE DIRECT MANIFESTATIONS OF BASIC FLUID PHYSICS PHENOMENA. THE ACUTE LACK OF KNOWLEDGE OF THE BASIC PHYSICAL MECHANISMS OF THE FLUID PROCESSES CREATING THE ABOVE NOTED ADVERSE ENVIRONMENTS RESULTS IN VERY COSTLY, INADEQUATE ENGINEERING METHODS FOR ESTIMATING AND ASSESSING THE EFFECTS OF THESE ENVIRONMENTS. THE CRUDE AND CONSERVATIVE ENGINEERING TECHNIQUES WHICH HAVE TO BE RESORTED TO, SIGNIFICANTLY AND DIRECTLY EFFECT THE DESIGN AND/OR OPERATIONAL MODES OF AIRCRAFT AND SPACE VEHICLES. THEORETICAL, ANALYTICAL, AND EXPERIMENTAL RESEARCH PROGRAMS ARE NECESSARY TO: DEFINE THE BASIC FLUID MECHANIC PROCESSES WHICH OCCUR DURING THE GENERATION, GROWTH AND SHEDDING OF VORTICES FROM CANTILEVERED BODIES AND THE INDUCED UNSTEADY PRESSURE FIELDS.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: DEISSLER, R. G. TEL.  
TECHNICAL SUMMARY

THE INTERACTION OF JETS WITH SOLID BOUNDARIES OR WITH OTHER JETS OR FLOWS OCCURS IN VTOL AIRCRAFT, JET INJECTION INTO COMBUSTION CHAMBERS, JET FLAPS AND OTHER AERODYNAMIC APPLICATIONS. THE FLOW PATTERNS CAN BE QUITE COMPLICATED EVEN FOR THE INVISCID CASE SINCE THE FREE STREAMLINES BOUNDING THE FLOW REGIONS MUST BE FOUND. FURTHER COMPLICATIONS ARE INTRODUCED BY FRICTION AND ENTRAINMENT EFFECTS AS WELL AS THE THREE DIMENSIONAL NATURE OF THE FLOW. ANALYTICAL STUDIES ARE BEING MADE TO AID IN THE PREDICTION OF JET

FLOW BEHAVIOR. NOISE RESEARCH: THE BASIC FLUID MECHANICS OF EXHAUST JET NOISE WILL BE STUDIED ANALYTICALLY AND EXPERIMENTALLY. THIS WILL BE DONE FOR BOTH SUBSONIC AND SUPERSONIC JETS TO BETTER REVEAL THE NOISE PRODUCING MECHANISMS. THE PERCEPTION OF SOUND WILL BE STUDIED IN TERMS OF THE RESPONSE OF THE HUMAN HEARING SYSTEM TO AN INCIDENT PRESSURE WAVEFORM. A SONIC BOOM OR NOISE PRODUCING DEVICE PRODUCES A PRESSURE SIGNAL. THE PRESSURE SIGNAL MUST THEN BE EVALUATED IN TERMS OF HUMAN RESPONSE IN ORDER TO DETERMINE THE LOUDNESS OR NOISE THAT WILL ACTUALLY BE PERCEIVED. A TRANSFER FUNCTION OF THE HUMAN AUDITORY SYSTEM HAS BEEN FORMULATED. IT WILL BE APPLIED TO VARIOUS SONIC BOOM PRESSURE WAVES AND NOISE SOURCES SO THAT THE PSYCHOLOGICAL RESPONSE CAN BE EVALUATED.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: HEINDL, C. J. TEL. 213-354-3279  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO ACQUIRE AN UNDERSTANDING OF THE BASIC FLUIDDYNAMIC AND CHEMICAL MECHANISMS IN PROBLEMS RELEVANT TO AERONAUTICS AND TO ENVIRONMENTAL POLLUTION. PRIMARY EMPHASIS WILL CENTER ON BOUNDARY LAYER DISTURBANCES IN SUPERSONIC TUNNELS AND CHEMICAL PROCESSES IN AIR POLLUTION. THE RELATION BETWEEN BOUNDARY LAYER STABILITY AND TRANSITION WILL BE STUDIED UTILIZING CORRELATED THEORETICAL AND EXPERIMENTAL APPROACHES. THE CHARACTERISTICS OF BOUNDARY LAYER DISTURBANCES PRODUCED BY SOUND WAVES AND THE TRENDS OF TRANSITION ACCORDING TO STABILITY THEORY WILL BE INVESTIGATED. THE RESULTS OF THE STUDIES ARE DIRECTLY APPLICABLE TO MODERN JET AIR TRANSPORTATION. THE CHEMICAL PROCESSES INVOLVED IN AIR POLLUTION WILL BE INVESTIGATED UTILIZING THE TECHNIQUES OF PHOTOCHEMISTRY, GAS CHROMATOGRAPHY, MASS SPECTROSCOPY, AND RAPID-SCAN INFRARED SPECTROSCOPY IN ORDER TO ELUCIDATE THE OVERALL AIR POLLUTION PROCESS.

RTOP NO. 129-01-20 TITLE: AERONAUTICAL FLUID DYNAMICS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: SCHWARTZ, I. R. TEL. 202-962-0171  
TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL STUDIES ARE TO BE EMPLOYED TO ACQUIRE AN UNDERSTANDING OF THE BASIC FLUID DYNAMIC MECHANISMS AND CONTROLLING PHYSICAL PARAMETERS IN PROBLEMS RELEVANT TO AERONAUTICS. THIS RESEARCH WILL BE PERFORMED IN THE AREAS OF: EXTERNAL FLOW FIELDS SUCH AS COMPRESSIBLE TURBULENT BOUNDARY LAYERS INCLUDING HEAT TRANSFER EFFECTS, FLOW SEPARATION, THREE DIMENSIONAL FLOW, MASS TRANSFER, AND THE INFLUENCE OF FREE STREAM DISTURBANCES ON BOUNDARY LAYER STABILITY AND TRANSITION; AIRCRAFT ENVIRONMENT INCLUDING CLEAR AIR TURBULENCE AND GROUND FOG; ENVIRONMENTAL POLLUTION INCLUDING SONIC BOOM GENERATION, PROPAGATION AND REDUCTION, AERODYNAMIC NOISE GENERATION, PROPAGATION FROM ENGINE EXHAUST JETS AND ROTATING MACHINERY (COMPRESSORS AND TURBINES) AND NOISE PREDICTION AND MINIMIZATION, AND CHEMICAL AND SMOKE POLLUTION FROM ENGINES; AND AIRCRAFT HAZARDS INCLUDING FLAMMABILITY AS INFLUENCED BY HIGH AND LOW

"G" EFFECTS AND GAS MIXTURES. THIS RESEARCH CONTRIBUTES TO PRESENT AND FUTURE AIRCRAFT DEVELOPMENT PROGRAMS.

RTOP NO. 129-01-21 TITLE: INTERNAL FLUID DYNAMICS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: SCHWARTZ, I. R. TEL. 202-962-0171

TECHNICAL SUMMARY

EXPERIMENTAL AND THEORETICAL STUDIES ARE TO BE CONDUCTED TO ACHIEVE A BASIC UNDERSTANDING OF THE FLUID FLOW AND HEAT AND MASS TRANSFER IN INTERNAL AND DUCTED CONFIGURATIONS. THE EFFORT WILL LOOK FAR AHEAD AND IDENTIFY AND STUDY FLUID DYNAMIC PROBLEMS THAT MUST BE SOLVED TO ALLOW MAJOR ADVANCES IN TECHNOLOGY. THIS RESEARCH WILL INCLUDE THE FOLLOWING AREAS: A. FLOWS IN INLETS, DUCTS, ROTATING MACHINERY. STUDIES OF BOUNDARY LAYERS IN INLETS WITH CENTERBODIES; EFFECTS OF ADVERSE PRESSURE GRADIENTS AND TURBULENCE; CHEMICAL KINETICS OF COMBUSTION AND THE EXPANSION OF PROPULSION GASES THROUGH NOZZLES; INVESTIGATION OF VORTEX FLOWS; FLOW IN ROTATING MACHINERY - INTERFERENCE EFFECTS, FLOW INTERACTION. EMPHASIS ON FLUID DYNAMIC PROBLEMS OF SUPERSONIC COMPRESSORS; STUDY THE BEHAVIOR OF THE TURBULENT BOUNDARY LAYER IN THE RANGE OF REYNOLDS NUMBERS AND STAGNATION TEMPERATURE REGIME RELEVANT TO HYPERSONIC INLETS - TESTING OF NEW THEORETICAL MODELS. INVESTIGATION OF VARIOUS CONCEPTS FOR HIGHER REYNOLDS NUMBER TRANSONIC TUNNELS. B. HEAT TRANSFER PROBLEMS IN INTERNAL FLOW. STUDIES OF HEAT TRANSFER IN COMPRESSIBLE TURBULENT BOUNDARY LAYER FLOWS - TESTING NEW THEORETICAL MODELS FOR SUPERSONIC AND HYPERSONIC FLOW REGIMES; INVESTIGATIONS OF THE DISTRIBUTION OF HEATING IN SHOCK-BOUNDARY LAYER INTERACTIONS; INFLUENCE OF SEPARATION AND REATTACHMENT;---

RTOP NO. 129-01-21 TITLE: INTERNAL FLUID DYNAMICS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RTOP ARE TO ACHIEVE A BASIC UNDERSTANDING OF FLUID FLOW, HEAT AND MASS TRANSFER IN INTERNAL AND DUCTED CONFIGURATIONS, AND BIOMEDICAL PHENOMENA AMENDABLE TO FLUID DYNAMIC ANALYSES. SPECIFIC OBJECTIVES ARE TO DEVELOP METHODS TO PREDICT FLOW FIELD BEHAVIOR INCLUDING FLOW FIELDS HAVING IMBEDDED SHOCK WAVES AND SHOCK BOUNDARY LAYER INTERACTIONS, TO PREDICT THE PRESSURE AND HEATING ASSOCIATED WITH SHOCK-BOUNDARY LAYER INTERACTIONS AND TO CONTINUE AND EXTEND BLOOD FLOW STUDIES CURRENTLY UNDERWAY.

RTOP NO. 129-01-21 TITLE: INTERNAL FLUID DYNAMICS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: AULT, G. M. TEL.

TECHNICAL SUMMARY

THE OBJECTIVE IS TO PROVIDE THE KNOWLEDGE NEEDED TO PREDICT AND CONTROL THE BEHAVIOR OF BOTH HOT GASEOUS WORKING FLUIDS AND COOLING



FLUIDS IN ENERGY-TRANSFER SYSTEMS. THE WORK INCLUDES EFFORTS IN FOUR DISTINCT RESEARCH AREAS, WHICH WILL BE DESCRIBED SEPARATELY: THERMODYNAMICS, TRANSPORT PROPERTIES, HEAT TRANSFER, AND CHEMICAL KINETICS. ALTHOUGH THESE AREAS ARE DISTINCT, THE WORK IS RELATED IN THAT IT IS ORGANIZED AROUND PROBLEMS IN SUCH ENERGY TRANSFER SYSTEMS AS PROPULSION AND POWER-GENERATION DEVICES, AND REACTORS FOR THE CONTROL OF POLLUTANTS IN THE EXHAUST FROM RECIPROCATING ENGINES. WITH THE EXCEPTION OF ACTUAL EXHAUST-GAS REACTORS, FULL-SCALE SYSTEMS ARE NOT STUDIED. THE APPROACH IS RATHER TO STUDY PROPERTIES AND PROCESSES APPLICABLE TO THE WHOLE CLASS OF ENERGY-TRANSFER SYSTEMS. THEORETICAL MODELS OF A PROCESS (E.G., TURBULENT HEAT TRANSFER OR FREEZING IN A FLOWING LIQUID) ARE DEVELOPED AND TESTED BY EXPERIMENT. EXPERIMENTAL MEASUREMENTS ARE MADE OF PROPERTIES (E.G., REACTION RATES OR DIFFUSION COEFFICIENTS) AND THE VALUES ARE USED IN ANALYZING THE BEHAVIOR OF ENERGY-TRANSFER SYSTEMS.

RTOP NO. 129-01-21 TITLE: INTERNAL FLUID DYNAMICS  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: HEINDL, C. J. TEL. 213-354-3279  
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS RTOP IS TO ACHIEVE A BASIC UNDERSTANDING OF THE FLUID FLOW AND HEAT AND MASS TRANSFER IN INTERNAL AND DUCTED CONFIGURATIONS. INCLUDED IS THE DEVELOPMENT AND REFINEMENT OF PREDICTION METHODS, AND THE CORRELATION OF EXPERIMENTAL RESULTS FOR CONVENIENT PRACTICAL USE AND COMPARISON WITH THEORY. THIS GENERAL INVESTIGATION CONSISTS OF TWO TASKS: (1) A STUDY OF THE HEAT TRANSFER AND BEHAVIOR OF TURBULENT BOUNDARY LAYER FLOWS IN THE REYNOLDS NUMBER AND STAGNATION TEMPERATURE REGIME RELEVANT TO HYPERSONIC INLETS AND (2) AN INVESTIGATION OF HIGH TEMPERATURE AND PLASMA FLOWS OVER ELECTRODE SURFACES. THE INVESTIGATION RELEVANT TO HYPERSONIC INLETS WAS INITIATED BECAUSE THE HEAT TRANSFER RATES IN THE INLET AND COMBUSTOR REGIONS OF HYPERSONIC VEHICLES CAN BE SUFFICIENTLY HIGH TO REQUIRE SIGNIFICANT COOLING. THE HIGH TEMPERATURE AND PLASMA FLOW INVESTIGATION WAS INITIATED BECAUSE THE HEAT TRANSFER TO THE ANODE OF AN ELECTRICAL PROPULSION DEVICE CAN BE VERY HIGH AND CAN EASILY CAUSE FAILURE BY BURNOUT. TEMPERATURE DISTRIBUTIONS ACROSS THE BOUNDARY LAYER OF HEATED AIR FLOW IN THE VICINITY OF INCIDENT AND REFLECTED SHOCK WAVES WILL BE OBTAINED WITH SMALL THERMOCOUPLE PROBES. LONGITUDINAL HEAT TRANSFER DISTRIBUTIONS ALONG THE WALL OF HYPERSONIC INLET AND DUCTED CONFIGURATIONS WILL BE DETERMINED FROM CALORIMETRIC MEASUREMENTS. THE PARALLEL-PLATE ELECTRODE EXPERIMENTS WILL BE CONDUCTED IN A TRANSPARENT VACUUM CHAMBER WITH ARGON FLOWING BETWEEN THE ELECTRODE SURFACES, SO THAT THE DISCHARGE MAY BE OBSERVED VISUALLY IN ADDITION TO MAKING MEASUREMENTS OF HEAT TRANSFER AND CURRENT DISTRIBUTIONS. DURING FY'70 THE AVAILABLE RESOURCES WILL BE DIVIDED APPROXIMATELY EVENLY BETWEEN THE STUDIES RELATED TO HYPERSONIC INLETS AND THOSE RELATED TO HIGH TEMPERATURE AND PLASMA FLOWS OVER ELECTRODE SURFACES.

RTOP NO. 129-01-22 TITLE: PHYSICAL GAS DYNAMICS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO ACQUIRE A BASIC PHENOMONOLOGICAL UNDERSTANDING OF FLUID BEHAVIOR IN WHICH MOLECULAR, ATOMIC AND IONIC PROCESSES PLAY A SIGNIFICANT OR CONTROLLING ROLE. IN GENERAL THIS WORK WILL FOCUS ON PROBLEMS TO BE FACED BY FUTURE MISSIONS AND FOR WHICH A BASIC UNDERSTANDING WILL HAVE A LONG TERM BENEFIT TO NASA. SPECIFICALLY THIS WORK WILL BE CONCERNED WITH GAS DYNAMIC LASERS, KINETICS OF REACTING GASES, VERY HIGH TEMPERATURE GAS TRANSPORT PROPERTIES, RADIATIVE HEAT TRANSFER, RADIATIVE PROPERTIES OF GASES, EQUILIBRIUM AND NONEQUILIBRIUM FLOW FIELDS, BOUNDARY LAYER PHENOMENA SUCH AS BOUNDARY LAYER-ABLATION VAPOR INTERACTIONS AND RAREFIED GAS DYNAMICS. THE WORK WILL CONSIST OF BOTH ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS USING SHOCK TUBES, FREE FLIGHT RANGES, WIND TUNNELS, ARC JETS AND COMPUTER FACILITIES. THE RESULTS WILL FIND APPLICATION IN SUCH AREAS AS PREDICTION OF CONVECTIVE AND RADIATIVE HEATING TO BE ENCOUNTERED ON MISSIONS TO VENUS, JUPITER AND HIGH SPEED RETURN TO EARTH, ANALYSIS OF THE BEHAVIOR OF LASER HEATING SYSTEMS AND LASER COMMUNICATION SYSTEMS, ISOTOPE SEPARATION SYSTEMS, CERTAIN MILITARY SYSTEMS AS WELL AS NEW UNFORESEEN AREAS.

RTOP NO. 129-01-22 TITLE: PHYSICAL GAS DYNAMICS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OVERALL OBJECTIVE IS TO OBTAIN A BASIC UNDERSTANDING OF MANY VARIED ASPECTS OF HIGH ENERGY FLUID FLOWS THROUGH THE APPLICATION OF BOTH ANALYTICAL AND EXPERIMENTAL APPROACHES. THIS WORK WILL BE CONDUCTED PRINCIPALLY IN-HOUSE WITH SOME CONTRACT SUPPORT. REAL GAS EFFECTS, RESULTING FROM THE INTERACTION OF A SPACE VEHICLE AND A PLANETARY ATMOSPHERE, SUCH AS HOT GAS RADIATION HEATING, GAS CHEMICAL KINETICS, HEAT TRANSFER, RADIO BLACK-OUT, ETC. WILL BE INVESTIGATED. EFFORT WILL ALSO BE APPLIED TO THE DEVELOPMENT OF HIGH ENTHALPY FACILITIES AND LOW PRESSURE INSTRUMENTATION AS WELL AS TO SPECIFIC STUDIES OF GAS-DYNAMIC LASERS, PARTICLE-SURFACE INTERACTIONS, COMBUSTION PROCESSES, ETC. THE RESULTS OF THESE STUDIES WILL INCREASE THE CAPABILITY TO PREDICT THE FLOW ABOUT AN ENTRY VEHICLE INCLUDING DRAG, HEATING, MASS LOSS, RADIO TRANSMISSION, ETC. HIGH ENERGY FACILITIES DEVELOPED WILL BE APPLIED TO STUDY SOME OF THE AFOREMENTIONED EFFECTS.

RTOP NO. 129-01-22 TITLE: PHYSICAL GAS DYNAMICS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: SCHWARTZ, I. R. TEL. 202-962-0171  
TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL STUDIES ARE TO BE CONDUCTED TO ACQUIRE A BASIC PHENOMONOLOGICAL UNDERSTANDING OF FLOWS IN WHICH MOLECULAR, ATOMIC AND IONIC PROCESSES - AS SUCH - PLAY A SIGNIFICANT

OR CONTROLLING ROLE. THE INTENT IS TO IDENTIFY THE SIGNIFICANT PHYSICAL ASPECTS OF PROBLEMS RELEVANT TO THE NEEDS OF NASA AND FOCUS THE RESEARCH EFFORT ON THESE. RESEARCH IS TO BE PERFORMED IN THE AREAS OF: GAS DYNAMIC LASERS INCLUDING CONTINUED RESEARCH ON CONTINUOUS - WAVE CHEMICAL LASERS, GAS DYNAMIC MIXING BEHIND SHOCK WAVES, MOLECULAR EXPANSION LASER, AND MPD ARC LASER; FLOW OVER ABLATING ENTRY OBJECTS - INFLUENCE OF MASS TRANSFER ON LAMINAR AND TURBULENT HEAT TRANSFER INCLUDING THREE DIMENSIONAL EFFECTS, CHEMICAL NON-EQUILIBRIUM, AND BOUNDARY LAYER TRANSITION; KINETICS OF REACTING GASES; TRANSPORT PHENOMENA IN MULTICOMPONENT PARTIALLY IONIZED GASES; ELECTRICAL FLUID PHENOMENA - ELECTROHYDRODYNAMICS; RAREFIED GAS DYNAMICS INCLUDING MOLECULAR BEAM SURFACE INTERACTION EXPERIMENTS, FLOW FIELD ANALYSIS, SHOCK STRUCTURE ANALYSIS. THIS RESEARCH IS APPLICABLE TO PLANETARY ENTRY, AND PREDICTING PERFORMANCE FOR ADVANCED AIRCRAFT SUCH AS HYPERSONIC AIRCRAFT SUCH AS HYPERSONIC AIRCRAFT, AEROSPACE PLANES, RECOVERABLE BOOSTERS, AND ORBITING SATELLITES.

RTOP NO. 129-02-20 TITLE: QUANTUM ELECTRONICS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: TALKIN, H. W. TEL. 202-962-6351  
TECHNICAL SUMMARY

TO CARRY OUT UNIQUE FUNDAMENTAL THEORETICAL AND EXPERIMENTAL RESEARCH IN THE PHYSICS OF QUANTUM ELECTRONICS; LASERS, MASERS, AND RELATED DEVICES. THIS RESEARCH, WHICH FILLS GAPS IN THE CENTERS' WORK, IS BEING CARRIED OUT UNDER A NUMBER OF UNIVERSITY GRANTS, EACH HAVING FOR PRINCIPAL INVESTIGATOR A SCIENTIST WITH A RECORD OF OUTSTANDING ACHIEVEMENT IN ORIGINAL RESEARCH IN THIS FIELD. THESE INVESTIGATORS ARE ALSO AVAILABLE FOR CONSULTATION BY CENTER SCIENTISTS AND ENGINEERS. THE PURPOSE IS TO PROVIDE THE FUNDAMENTAL KNOWLEDGE NECESSARY FOR THE ADVANCEMENT OF OPTICAL TECHNOLOGY WHICH CAN UTILIZE COHERENT RADIATION IN ELECTRONIC COMMUNICATIONS, DISPLAY DEVICES, COMPUTERS AND GENERAL MEASUREMENTS INSTRUMENTATION TO BE APPLIED IN PLANETARY EXPLORATION, SPACE PHYSICS, AND AVIONICS. SUBJECTS TO BE INVESTIGATED INCLUDE SPECTROSCOPY, LIGHT SCATTERING, MAGNETO-OPTICAL EFFECTS, PLASMA STUDIES, AND OPTICAL STUDIES OF SEMICONDUCTORS AND CRYSTALLINE SOLIDS.

RTOP NO. 129-02-20 TITLE: QUANTUM ELECTRONICS  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: ROBERTS, L. W. TEL. 617-494-2028  
TECHNICAL SUMMARY

TO CARRY OUT FUNDAMENTAL STUDIES BOTH THEORETICAL AND EXPERIMENTAL IN THE PHYSICS OF QUANTUM ELECTRONICS. A COMPREHENSIVE IN-HOUSE RESEARCH PROGRAM IS BEING CARRIED OUT ON THE PHYSICAL PROCESSES INVOLVED IN LASERS, MASERS AND RELATED DEVICES. THE PROGRAM IS BEING CARRIED OUT BY A GROUP OF 25 SENIOR RESEARCH WORKERS COMPOSED OF PHYSICISTS AND ELECTRICAL ENGINEERS. THE PURPOSE OF THE PROGRAM IS TO PROVIDE THE FUNDAMENTAL KNOWLEDGE NECESSARY FOR THE DEVELOPMENT OF AN OPTICAL TECHNOLOGY WHICH CAN UTILIZE COHERENT

RADIATION IN COMMUNICATIONS, DISPLAY DEVICES, AND GENERAL MEASUREMENTS INSTRUMENTATION TO BE APPLIED IN PLANETARY EXPLORATION, SPACE PHYSICS AND AVIONICS. SUBJECTS TO BE INVESTIGATED INCLUDE SPECTROSCOPY, LIGHT SCATTERING, MAGNETO-OPTICAL EFFECTS, PLASMA STUDIES AND OPTICAL STUDIES OF SEMICONDUCTORS AND CRYSTALLINE SOLIDS.

RTOP NO. 129-02-21 TITLE: ELECTRON-WAVE INTERACTIONS AND  
ELECTROMAGNETIC RESEARCH

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: LAURENCE, J. C. TEL.

TECHNICAL SUMMARY

OBJECTIVE: THE PRIMARY OBJECTIVE OF THE LEWIS PROGRAM IS TO ACHIEVE INTENSE, STEADY MAGNETIC FIELDS IN LARGE VOLUME WITH A MINIMUM MASS AND POWER REQUIREMENT. PROGRESS TOWARD THIS OBJECTIVE REQUIRES BOTH BASIC AND APPLIED RESEARCH ON WAYS TO IMPROVE THE CURRENT DENSITY, OPERATING TEMPERATURE, AND STRENGTH OF SUPERCONDUCTING MATERIALS SUITABLE FOR USE IN LARGE COILS. A SECOND OBJECTIVE IS TO ACHIEVE BETTER UNDERSTANDING OF THE PHYSICAL PROCESSES INVOLVED IN CONDUCTION OF ELECTRICITY BOTH IN THE NORMAL AND THE SUPERCONDUCTING STATE, WITH A VIEW TO IMPROVING THE PERFORMANCE OF ELECTRICAL COMPONENTS OF AEROSPACE POWER AND PROPULSION SYSTEMS. APPROACH: SUPERCONDUCTORS WILL BE STUDIED THEORETICALLY AND EXPERIMENTALLY ON BOTH PHYSICS AND ENGINEERING LEVELS. IN NORMAL METALS AND SEMICONDUCTORS THE GALVANO-MAGNETIC EFFECTS (MAGNETORESISTANCE, HALL EFFECT, MAGNETOTHERMAL EFFECTS, ETC.) WILL BE STUDIED, ESPECIALLY IN HIGH FIELDS WHERE LANDAU QUANTIZATION IS IMPORTANT. THE PROCESSES OF EXCITATION AND DISSOCIATION OF GASES IN STRONG ELECTRIC AND MAGNETIC FIELDS WILL BE STUDIED. THE INTENT IN EACH AREA WILL BE TO UNDERSTAND AND TO DEVELOP MATERIALS MATERIALS AND PROCESSES WITH UNIQUE CHARACTERISTICS FOR SPECIFIC APPLICATIONS. VARIOUS FORMS OF SUPERCONDUCTORS (WIRE, RIBBON, COMPOSITES, ETC.) WILL BE TESTED IN SHORT SAMPLES AND IN ACTUAL COILS TO ASCERTAIN RELATIVE MERITS OF DIFFERENT MATERIALS AND CONSTRUCTION TECHNIQUES. IMPROVED SUPERCONDUCTING COMPOSITES WILL BE SOUGHT BY ANALYTIC AND EXPERIMENTAL METHODS IN ORDER TO IMPROVE SUPERCONDUCTING MAGNETS. THE HIGH FIELD SUPERCONDUCTING AND CRYOGENIC MAGNETS, DEVELOPED IN THE LERC MAGNET TECHNOLOGY PROGRAM WILL BE USED IN SUPERCONDUCTOR AND GALVANOMAGNETIC EXPERIMENTS.

RTOP NO. 129-02-21 TITLE: ELECTRON-WAVE INTERACTIONS

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: ROTH, H. TEL. 617-494-2329

TECHNICAL SUMMARY

TO CONTRIBUTE TO THE DEVELOPMENT OF ELECTRICAL COMPONENTS AND DEVICE CONCEPTS VITAL TO THE INCREASINGLY SOPHISTICATED REQUIREMENTS OF SPACE EXPLORATION AND NEW AVIATION TECHNOLOGY THROUGH FUNDAMENTAL STUDIES IN SOLID STATE PHYSICS AND RELATED FIELDS. EXPERIMENTAL AND THEORETICAL RESEARCH WILL BE CARRIED OUT IN THE FOLLOWING AREAS: 1) ELECTRICAL TRANSPORT AND GALVANOMAGNETIC EFFECTS IN HEAVENLY DOPED AND AMORPHOUS SEMICONDUCTORS, DEVELOPMENT OF NEW SOLID STATE

MICROWAVE ENERGY SOURCES UTILIZING THE GUNN EFFECT AND PLASMAS IN SEMICONDUCTORS MICROWAVE GENERATION BASED ON THE CYCLOTRON RESONANCE INTERACTION OF ENERGETIC ELECTRONS AND ELECTROMAGNETIC WAVES, AND THE DEVELOPMENT OF UNIQUE ELECTROMAGNETIC TRANSDUCERS; 2) LOW TEMPERATURE PHYSICS- ENHANCEMENT OF THE TRANSITION TEMPERATURE IN SUPERCONDUCTING THIN FILMS, SENSITIVE MICROWAVE DETECTION USING JOSEPHSON JUNCTIONS, AND ULTRASONIC STUDIES OF CRITICAL POINT PHENOMENA; 3) OPTICAL EFFECTS IN SOLIDS- PHOT-GENERATION AND MULTIPLICATION OF COMPOUND SEMICONDUCTORS, ELECTRO-OPTIC MEMORY PROPERTIES OF SEMICONDUCTOR-DIELECTRIC JUNCTIONS, FREQUENCY MODULATION OF SEMICONDUCTOR LASERS, AND INTERACTION OF ELECTROMAGNETIC WAVES WITH DIELECTRIC MEDIA; 4) SOLID STATE SPECTROSCOPY-ELECTRON SPIN RESONANCE AND RELAXATION STUDIES OF IMPURITIES AND DEFECTS IN SOLIDS, MOSSBAUER MEASUREMENTS OF THE PROPERTIES OF DILUTE MAGNETIC ALLOYS, AND INVESTIGATION OF BULK DENSITY-OF-STATES AND SURFACE PROPERTIES OF MATERIALS USING PHOTOEMISSION; 5) CRYSTALLINE DEFECTS- STUDIES OF DEFECTS INTRODUCED BY DOPING, MECHANICAL AND ELECTRICAL STRESS, AND HIGH ENERGY IRRADIATION USING TECHNIQUES SUCH AS ULTRASONIC ATTENUATION AND MEASUREMENTS OF THERMAL CONDUCTIVITY AND HANDLING PHENOMENA; THIS RESEARCH PROGRAM IS CLOSELY COORDINATED WITH RELATED PROGRAMS IN ELECTRONIC MATERIALS AND ADVANCED COMPONENT RESEARCH AND DEVELOPMENT.

RTOP NO. 129-02-21 TITLE: ELECTRON-WAVE INTERACTIONS  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: HEINDL, C. J. TEL. 213-354-3279  
TECHNICAL SUMMARY

THIS IS A PROGRAM OF EXPERIMENTAL AND THEORETICAL RESEARCH IN THE INTERACTION OF ELECTRONS WITH ELECTRIC AND MAGNETIC FIELDS. ITS OBJECTIVE IS TO PROVIDE BETTER UNDERSTANDING OF OSCILLATION AMPLIFICATION, AND DETECTION IN THIN FILMS AND SEMICONDUCTING MATERIALS; CERTAIN ASPECTS OF SUPERCONDUCTIVITY; AND REFRACTION AND ABSORPTION IN SOLIDS. THE INTENDED APPLICATION OF THE KNOWLEDGE OBTAINED IN THESE EFFORTS IS THE DEVELOPMENT OF BETTER COMPONENTS FOR SPACE ELECTRON SYSTEMS. DURING THE COMING YEAR, WORK WILL BE UNDERTAKEN ON THE FOLLOWING SPECIFIC TOPICS: (1) DETERMINING THE CHARACTERISTICS OF MAGNETIC THIN FILMS AS COMPUTER STORAGE ELEMENTS, (2) INVESTIGATING THIN FILM SUPERCONDUCTOR JUNCTIONS AS FAST SWITCHING ELEMENTS FOR COMPUTERS, (3) EXAMINING THE ELECTRONIC PROPERTIES OF THIN-INSULATOR FILMS FOR IMPROVED ELECTRONIC DEVICES, (4) INVESTIGATING SPACE-CHARGE-LIMITED TRIODES, (5) INVESTIGATING ELECTRO-OPTICAL PROPERTIES OF DIELECTRICS, (6) MEASURING SIZE AND SHAPE OF THE FERMI SURFACE OF CERTAIN METALS AND BINARY COMPOUNDS, (7) STUDYING PHOTO RESPONSE IN SEMICONDUCTORS, AND (8) UNDERTAKING THEORETIC STUDIES IN SPECIFIC AREAS OF QUANTUM THEORY SIGNIFICANT TO SOLID STATE PHYSICS. THE MAGNETIC THIN FILM WORK IS INTENDED FOR HIGH-DENSITY MAGNETO-OPTIC INFORMATION STORAGE FOR MASS MEMORY OR RECORDING APPLICATION. THE THIN FILM SUPERCONDUCTOR INVESTIGATION WILL HOPEFULLY LEAD TO VERY HIGH SPEED COMPUTER LOGIC DEVICES AND TRANSMISSION LINES. THE STUDIES OF THIN-INSULATOR FILMS HAVE ALREADY LED TO A NEW-TYPE THERMAL DETECTOR, AND WORK IS NOW AIMED TOWARD THE ULTIMATE DEVELOPMENT OF NEW TYPES OF SWITCHING AND ENERGY CONVERSION

DEVICES. THE STUDIES OF ELECTRO-OPTIC EFFECT WILL HOPEFULLY LEAD TO NEW TYPES OF LIGHT MODULATORS AND DIRECTION SENSORS. FROM THE FERMI SURFACE STUDIES IT IS ANTICIPATED THAT SUFFICIENT UNDERSTANDING OF THE TRANSPORT PROPERTIES OF THESE MATERIALS WILL BE OBTAINED TO FACILITATE THEIR UTILIZATION IN FUTURE SOPHISTICATED ELECTRONIC DEVICES. THE PHOTO RESPONSE MEASUREMENTS SHOULD YIELD INFORMATION LEADING TO IMPROVED SEMICONDUCTOR UNITS FOR LIGHT DETECTION AND ENERGY CONVERSION. THE STUDIES OF BAND STRUCTURE IN THE THEORETICAL QUANTUM WORK POINT ULTIMATELY TOWARD IMPROVED SOLID STATE DEVICES.

RTOP NO. 129-02-21 TITLE: ELECTRON-WAVE INTERACTIONS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: JOHNSON, P. S. TEL. 202-962-6351  
TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL RESEARCH IN THE AREAS OF: ELECTRICAL TRANSPORT PHENOMENA SUCH AS INTERACTION OF ELECTRONS WITH ACOUSTIC WAVES AND OTHER LATTICE VIBRATIONS AS WELL AS WITH IMPRESSED ELECTRIC AND MAGNETIC FIELDS; GENERATION AND AMPLIFICATION PROCESSES IN SEMICONDUCTORS; SUPERCONDUCTIVITY PHENOMENA SUCH AS IMPROVED PAIRING OF ELECTRONS EITHER WITH OR WITHOUT INTERVENTION OF PHONONS TO PRODUCE HIGHER TEMPERATURE SUPERCONDUCTORS; THIN FILM PHENOMENA TO DETERMINE ELECTRON INTERACTION WITH AN IMPERFECT OR INCOMPLETE LATTICE UNDER CONDITIONS OF RESTRICTED ELECTRON MOTION CAUSED BY A PREDOMINANTLY TWO DIMENSIONAL STRUCTURE; SOLID STATE SPECTROSCOPY OF LASER ACTIVE ATOMS IN A CRYSTALLINE HOST LATTICE; AMORPHOUS SEMICONDUCTORS TO PROVIDE IMPROVED UNDERSTANDING OF SWITCHING AND MEMORY PROPERTIES SO THAT THESE UNIQUE CHARACTERISTICS CAN BE FULLY APPLIED. THIS RESEARCH CONTRIBUTES TO THE DEVELOPMENT OF NEW AND IMPROVED ELECTRONIC COMPONENTS AND DEVICES NEEDED TO MEET INCREASED SOPHISTICATION AND RELIABILITY REQUIREMENTS IN THE SPACE EXPLORATION AND AVIATION TECHNOLOGY PROGRAMS.

RTOP NO. 129-02-21 TITLE: ELECTRON-WAVE INTERACTIONS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

BASIC RESEARCH IS BEING PERFORMED AT THE BIOMOLECULAR LEVEL TO DETERMINE THE MECHANISM OF CELL DIVISION. MEASUREMENTS ARE MADE OF TRANSMEMBRANE POTENTIALS WITH PRECISE MEASUREMENT OF CONCENTRATION AND DISTRIBUTION OF SIGNIFICANT IONS (I.E.  $Na^+$ ,  $K^+$ ,  $Ca^{++}$ ,  $Cl^-$ ). RESULTS OF THIS RESEARCH WILL THEN PROVIDE AN UNDERSTANDING OF THE INFLUENCES OF VARIOUS SPACE ENVIRONMENTAL FACTORS ON MAN'S PERFORMANCE IN SPACE. THIS BASIC RESEARCH SUPPORTS THE DEVELOPMENT OF A QUANTITATIVE MATHEMATICAL THEORY ON THE ELECTRO-OSMOTIC MECHANISMS INVOLVED IN MITOTIC PROCESSES. IN A CURRENT INVESTIGATION STUDIES OF ABNORMAL CELLS LED TO THE DISCOVERY OF MITOTIC STIMULATION TAKING PLACE IN SARCOMA CELLS IN CULTURE THROUGH INTERCELLULAR BRIDGES. THIS WORK CONTINUES TO DETERMINE IF THERE IS, IN FACT, INTERCELLULAR MOLECULAR COMMUNICATION IN HUMAN TISSUE. PART OF THIS WORK WILL REQUIRE DEVELOPMENT OF ULTRAMICRO TECHNIQUES FOR HIGHLY



**LOCALIZED CHEMICAL ANALYSIS OF SUB-CELLULAR STRUCTURES WITHIN HUMAN CELLS USING NEWLY AVAILABLE ELECTRON MICROPROBE INSTRUMENTATION.**

**RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS**

**ORGANIZATION: NASA HEADQUARTERS**

**MONITOR: THOM, K.**

**TEL. 202-962-6351**

**TECHNICAL SUMMARY**

FUNDAMENTAL RESEARCH ON SPECIAL PLASMA DYNAMIC PROBLEMS, UNDER A GRANT AND CONTRACT PROGRAM, UTILIZING UNIQUE EXPERTISE AND COMPETENCE AVAILABLE AT UNIVERSITIES AND OTHER RESEARCH INSTITUTIONS, FOR THE ADVANCE OF PLASMA DYNAMICS BEYOND THE CENTERS' CAPACITIES AND RESOURCES. SPECIFIC RESEARCH OBJECTIVES ARE: PLASMA BOUNDARY LAYERS, PLASMA SURFACE INTERACTIONS, EXCITATION AND IONIZATION CROSS SECTIONS AT LOW (THERMAL) IMPACT ENERGIES AND IN GASES THAT ARE CANDIDATES AS WORKING FLUIDS IN PLASMA THRUSTERS AND PLASMA POWER SOURCES, PLASMA TRANSPORT PROPERTIES, PLASMA TURBULENCE, NON-EQUILIBRIA IN PLASMAS, THE INTERACTION OF PLASMAS AND CHARGED PARTICLES WITH EXTERNAL FORCE FIELDS, PROPERTIES OF URANIUM PLASMAS, AND INTERACTIONS OF NEUTRON FLUX WITH URANIUM PLASMA FOR INVESTIGATION OF FISSIONING PLASMAS.

**RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS**

**ORGANIZATION: JET PROPULSION LABORATORY**

**MONITOR: HEINDL, C. J.**

**TEL. 213-354-3279**

**TECHNICAL SUMMARY**

THE OBJECTIVE OF THIS RESEARCH IS TO ADVANCE THE SCIENTIFIC UNDERSTANDING OF ELECTROMAGNETIC FIELD INTERACTIONS WITH IONIZED GASES (PLASMAS) AND THE MOTION OF PLASMAS UNDER THE INFLUENCE OF EXTERNAL ELECTROMAGNETIC FIELDS. THE WORK WILL EMPHASIZE ADVANCEMENT OF KNOWLEDGE IN CHEMICAL KINETICS (RATES OF DISSOCIATION, EXCITATION, IONIZATION, AND RECOMBINATION) AND THE ATOMIC AND MOLECULAR PROPERTIES, SUCH AS LIFETIMES, CROSS SECTIONS, AND ENERGY LEVELS, WHICH ARE SIGNIFICANT IN PLASMA DYNAMIC SYSTEMS. THE APPLICATIONS FOR WHICH THESE RESULTS WILL BE NEEDED ARE: MPD ACCELERATORS FOR SPACECRAFT ELECTRIC PROPULSION, MHD GENERATORS FOR NUCLEAR POWER CONVERSION, HIGH POWER LASERS FOR COMMUNICATION, AND THERMIONIC DIODES FOR POWER CONVERSION. THE SPECIFIC EFFORTS TO BE UNDERTAKEN IN FY 70 ARE: (1) INELASTIC RATE PROCESS AND RADIATIVE TRANSPORT IN PARTIALLY IONIZED GASES, (2) ATOMIC AND MOLECULAR POPULATION INVERSION IN MAGNETOGASDYNAMIC DEVICES FOR APPLICATION TO HIGH POWER LASERS, (3) ION CYCLOTRON RESONANCE, MICROWAVE AND ELECTRON SCATTERING STUDIES TO OBTAIN REACTION CROSS SECTIONS, MOLECULAR PARAMETERS AND ENERGY LEVELS SIGNIFICANT TO LASER APPLICATIONS, AND (4) PLASMA THERMIONICS RESEARCH AIMED TOWARD IMPROVEMENT IN PERFORMANCE OF CESIUM THERMIONIC DIODES.

RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: RAYLE, W. D. TEL. 216-433-4000  
TECHNICAL SUMMARY

RESEARCH IS DIRECTED TOWARD GAINING UNDERSTANDING OF PLASMA BEHAVIOR IN USEFUL RANGES OF DENSITY, TEMPERATURE, AND MAGNETIC FIELD STRENGTHS. THE AIM IS TO GAIN THE ABILITY TO GENERATE, CONFINE, AND MANIPULATE PLASMAS OF DESIRABLE CHARACTERISTICS IN WAYS RELEVANT TO POTENTIAL APPLICATIONS OF IMPORTANCE TO NASA PROGRAMS. THEORETICAL AND EXPERIMENTAL TOOLS WILL BE INVESTIGATED AND DEVELOPED TO IMPROVE OUR UNDERSTANDING AND TO CHECK THAT UNDERSTANDING WITH SPECIFIC EXPERIMENTS. APPLICATIONS FOR THE KNOWLEDGE SOUGHT ARE WIDESPREAD, INCLUDING MHD POWER GENERATION, PLASMA THRUSTERS AND THERMONUCLEAR PLASMAS, AND THE TENUOUS ASTROPHYSICAL PLASMAS SUCH AS THAT MAKING UP THE SOLAR WIND. EXPERIMENTALLY, THE APPROACH IS FIRST TO IDENTIFY SPECIFIC PLASMA PROCESSES RELEVANT TO SPECIFIC POTENTIAL APPLICATIONS, CONCERNING WHICH THE PRESENT STATE OF KNOWLEDGE IS INADEQUATE. THEN TO DEVISE MEANS BY WHICH A PLASMA DEMONSTRATING SUCH A PROCESS MAY BE GENERATED AND DIAGNOSED. AMONG THE PLASMA PROCESSES BEING STUDIED EXPERIMENTALLY AND/OR THEORETICALLY ARE LOSS-CONE INSTABILITIES, NON-EQUILIBRIUM IONIZATION, INTERACTION OF FLOWING PLASMAS WITH MAGNETIC FIELDS, TURBULENCE AND DIFFUSION, PLASMA WAVE INTERACTIONS FOR PLASMA HEATING AND AS DIAGNOSTIC TOOLS, AND PLASMA ION HEATING PROCESSES.

RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

STUDY IS MADE OF FARADAY-TYPE LINEAR-PLASMA-ACCELERATORS WITH AIM OF PROVIDING HIGH-DENSITY, 40,000 FT/SEC FLOW FOR LAB. SIMULATION OF ATMOSPHERIC ENTRY. FACILITIES USED IN STUDIES ARE 1-IN. PLASMA ACCELERATOR AND 20 MW PLASMA ACCELERATOR FACILITY. IN THEORETICAL MPD RESEARCH, ANALYSIS PERTAINING TO USE OF AN IONIZED BARIUM CLOUD AS A MEANS OF DETERMINING THE TOPOLOGY OF THE EARTH'S MAGNETIC FIELD AND CONVECTIVE MOTIONS WITHIN IT ARE CONTINUED. THEORETICAL STUDIES ARE MADE OF NONLINEAR BEHAVIOR OF COLLISIONLESS PLASMA AND NATURE OF PLASMA TURBULENCE, SUCH STUDIES BEING NEEDED IN DEVELOPING DEEPER UNDERSTANDING OF GEOPHYSICAL PHENOMENA. THEORETICAL DETERMINATION IS MADE OF TRANSPORT PROPERTIES OF HIGH-TEMPERATURE GASES AND PLASMAS. EXPLOITATION OF NUMERICAL COMPUTER EXPERIMENT TECHNIQUES FOR SOLVING ASTRONOMICAL AND PLASMA PROBLEMS CONTINUES. PREVIOUSLY UNIDENTIFIED SPECTRAL LINES OF HIGHLY IONIZED ELEMENTS ARE PRODUCED IN THE LAB. AND IDENTIFIED. RADIATION SOURCES INCLUDE GIANT-PULSE-LASER PRODUCED PLASMAS, PLASMA-FOCUS APPARATUS AND THETA-PINCH APPARATUS. RESULTS WILL BE USED IN IDENTIFYING FOR FIRST TIME SOLAR SPECTRA OBTAINED BY ROCKETS AND SATELLITES; WIDESPREAD DEMAND BY THE SCIENTIFIC COMMUNITY FOR SUCH SPECTRA WILL BE SATISFIED. THEORETICAL AND DIAGNOSTIC STUDIES ARE MADE OF ION LASERS WITH THE AIM OF INCREASING THEIR POWER (>100 W) AND EFFICIENCY (>0.1%). SUCH LASERS ARE UNIQUE IN PRODUCING OPTICAL RADIATION IN THE VISIBLE (BLUE-GREEN), HENCE HAVE IMPORTANT POTENTIAL APPLICATIONS (E.G. SPACE AND UNDERWATER COMMUNICATION).

ADVANCEMENT OF ARC-HEATER TECHNOLOGY IS SOUGHT WITH THE OBJECT OF IMPROVING AND EXTENDING LAB. SIMULATION OF HYPERSONIC FLIGHT; EFFORTS INCLUDE EXTENDING ENTHALPY AND PRESSURE OF MOST ADVANCED HEATERS AND CONTINUED DEVELOPMENT OF ROTARY-ARC HEATERS. ONE RESEARCH USE MADE OF THE MOST ADVANCED ARC-HEATER FLOW-FACILITY IS STUDY OF ELECTRON ATTACHMENT BY ELECTROPHYLIC MATERIALS.

RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTCP IS TO ADVANCE THE SCIENTIFIC UNDERSTANDING OF (1) ELECTROMAGNETIC FIELD INTERACTIONS WITH PLASMAS, (2) GENERATION OF PLASMAS AND (3) PLASMA MOTION. SPECIFICALLY THE WORK WILL BE CONCERNED WITH THE ADVANCEMENT OF ELECTRIC ARC PHYSICS FOR THE PRODUCTION OF HIGH ENTHALPY GAS FLOWS, LINEAR ACCELERATION OF UNSEEDED NITROGEN OR AIR, PLASMA PROPERTIES SUCH AS TRANSITION PROBABILITIES, ETC., CONTINUUM MHD THEORY FOR PULSED PLASMA ACCELERATION AND COMPUTER SIMULATIONS OF PLASMA PARTICLE DYNAMICS AND THEORETICAL ANALYSIS OF THE INTERACTION OF SPACE MAGNETIC FIELDS AND THE SOLAR WINDS. THIS INFORMATION CAN HAVE APPLICATION IN MANY FIELDS INCLUDING SIMULATION OF PLANETARY ENTRY HEATING ENVIRONMENTS, ELECTROMAGNETIC PROPULSION, SPACE POWER GENERATION, LASER POWER AND LASER COMMUNICATIONS AND SOLAR PHYSICS.

RTOP NO. 129-02-22 TITLE: PLASMA DYNAMICS  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: MACRAKIS, M. TEL. 617-494-2474  
TECHNICAL SUMMARY

TO ADVANCE THE UNDERSTANDING OF (1) ELECTROMAGNETIC AND ACOUSTIC INTERACTIONS WITH IONIZED GASES OR SOLID STATE PLASMAS; (2) THE PRODUCTION, DECAY, EXCITATION OF SUCH PLASMAS; (3) RADIATION FROM PLASMAS; (4) PLASMA MOTION, FOR ELECTROMAGNETIC PROPULSION AND POWER GENERATION IN SPACE, AND FOR POSSIBLE GENERATION OF COHERENT RADIATION; (5) REACTION KINETIC PHOTOIONIZATION AND EXCITATION OF ATOMS AND DIATOMIC MOLECULES THROUGH COLLISIONS. AMONG SPECIFIC OBJECTIVES WE LIST: 1) STUDY OF THE OPTICAL AND DYNAMIC PROPERTIES OF LASER-PRODUCED PLASMAS. 2) EXPERIMENTAL RESEARCH ON PLASMA PRODUCTION BY LASER IRRADIATION OF SOLID AND GASEOUS TARGETS. 3) THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE INTERACTIONS OF COHERENT EM WAVES AND PARTICLES WITH GASEOUS AND SOLID STATE PLASMAS, WITH APPLICATIONS TO WAVE PROPAGATION STUDIES, TO MICROFIELD ANALYSIS AND PLASMA DIAGNOSTICS. 4) ANALYSIS OF PLASMA NON-EQUILIBRIA DURING RAPID EXPANSION FOR ESTABLISHING LASING POSSIBILITIES

RTOP NO. 129-02-23 TITLE: NUCLEAR PHYSICS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: BLUE, J. W. TEL.

TECHNICAL SUMMARY

THIS WORK FITS INTO FOUR CATEGORIES: (1) NUCLEAR MODEL DEVELOPMENT, (2) BASIC NUCLEAR DATA, (3) REACTOR RELATED STUDIES, AND (4) NUCLEAR INSTRUMENTATION. PROJECT 1: CONCERNS THE DEVELOPMENT OF MATHEMATICAL MODELS OF THE NUCLEUS AND METHODS OF CALCULATION SO THAT IT IS POSSIBLE TO PREDICT THE OUTCOME OF ANY NUCLEAR INTERACTION. PROJECT 2: IS AN EXPERIMENTAL PROGRAM OF NUCLEAR MEASUREMENTS OF CROSS SECTIONS, ENERGY SPECTRA OF SECONDARY PARTICLES, LIFETIMES AND OTHER CHARACTERISTICS OF NUCLEAR STATES. PROJECT 3: CONSISTS OF MEASUREMENTS AND CALCULATIONS OF PHENOMENA RELATED TO REACTOR TECHNOLOGY INCLUDING SHIELDING. PROJECT 4: IS THE DEVELOPMENT OF CERTAIN NUCLEAR INSTRUMENTATION FOR THE MEASUREMENT OF THE ENERGY OF NEUTRONS, CHARGED PARTICLES OR GAMMA RAYS. THE RESULTS OF THIS WORK WHILE NOT DIRECTED AT A SPECIFIC TECHNOLOGICAL APPLICATION IS INTENDED TO CONTRIBUTE TO THE ADVANCED TECHNOLOGIES OF SPACE SHIELDING, AND PROPULSION AND POWER REACTOR DESIGN INCLUDING SHIELDING.

RTOP NO. 129-02-23 TITLE: NUCLEAR PHYSICS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THIS RESEARCH PROGRAM IN INTERMEDIATE ENERGY PHYSICS IS DIRECTED TOWARD A BETTER UNDERSTANDING OF THE ATOMIC NUCLEUS, INCLUDING ITS STRUCTURE, THE NATURE OF THE FORCES WHICH ACT AMONG ITS CONSTITUENTS, AND ITS BEHAVIOR DURING INTERACTIONS WITH SUB-ATOMIC PARTICLES, SPECIFICALLY, BEAMS OF PROTONS, PIONS, AND MUONS AVAILABLE AT THE SPACE RADIATION EFFECTS LABORATORY. BASIC RESEARCH PROVIDES THE DATA UPON WHICH VALID THEORETICAL MODELS MAY BE CONSTRUCTED; THE EXTENSION OF THESE MODELS TO ENGINEERING PROBLEMS DEALING WITH RADIATION SHIELDING. THREE UNIVERSITIES, THE UNIVERSITY OF VIRGINIA, VIRGINIA POLYTECHNIC INSTITUTE, AND THE COLLEGE OF WILLIAM AND MARY ARE PARTICIPATING IN THIS PROGRAM. IN-HOUSE WORK CONTINUES INVESTIGATIONS OF THE BASIC INTERACTIONS OF ENERGETIC PROTONS AND MESONS TO VERIFY THE VARIOUS THEORETICAL MODELS USED TO PREDICT BOTH THE CASCADE AND EVAPORATION PROCESSES OF SECONDARY PRODUCTION AND NUCLEAR ENERGY DECAY.

RTOP NO. 129-03-20 TITLE: HIGH TEMPERATURE MATERIALS AND COATINGS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVE IS TO DETERMINE THE BEHAVIOR AND THE SUITABILITY OF COATED OR UNCOATED METALLIC ALLOYS FOR SERVICE IN ADVANCED AIRCRAFT AND SPACECRAFT. THE SCOPE OF THE STUDIES SHALL PRIMARILY ENCOMPASS ALLOYS OF NICKEL, COBALT, AND THE REFRACTORY METALS AS WELL AS COATINGS FOR THERMAL CONTROL OR FOR PROTECTION FROM ATTACK BY

ENVIRONMENTAL SPECIES. THE MATERIALS, USUALLY THIN SHEET, SHALL BE EXPOSED TO APPROPRIATE CYCLES OF TEMPERATURE, PRESSURE, STRESS, AND TIME. SOME ATTENTION WILL ALSO BE GIVEN TO EXPLORATION OF ADVANCED FABRICATION AND JOINING METHODS AND TO THE ENVIRONMENTAL EXPOSURE OF FABRICATED SPECIMENS WITH OR WITHOUT APPLIED STRESS. LIMITED WORK WILL ALSO BE DIRECTED AT STUDY OF THE MECHANISMS INVOLVED IN THE DEGRADATION OF THERMAL CONTROL COATINGS. SOME CONTRACTUAL EFFORT WILL BE MADE TO COMPLEMENT THE IN-HOUSE STUDIES. THE RESULTS OF THESE STUDIES WILL PROVIDE INFORMATION ON THE BASIC BEHAVIOR OF HIGH TEMPERATURE ALLOYS AND COATINGS AND WILL ESTABLISH THE SUITABILITY AND LIMITATIONS OF THESE MATERIALS FOR APPLICATIONS IN ADVANCED AEROSPACE VEHICLES.

RTOP NO. 129-03-20 TITLE: HIGH TEMPERATURE MATERIALS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: AULT, G. M. TEL. 000-000-6387  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RESEARCH ARE TO DEVELOP NEW HIGH TEMPERATURE MATERIALS WITH SUPERIOR PROPERTIES FOR VARIOUS AEROSPACE APPLICATIONS AND TO EXTEND PROCESSING TECHNOLOGY SO THAT ADVANCED MATERIALS CAN BE EFFECTIVELY EXPLOITED IN SUCH APPLICATIONS. A SEPARATE OBJECTIVE IS TO DEVELOP SUITABLE LOW-COST MATERIALS FOR APPLICATION TO AFTERBURNER DEVICES INTENDED TO REDUCE THE LEVEL OF AUTOMOBILE EXHAUST GAS EMISSIONS. TO ACHIEVE THESE OBJECTIVES RESEARCH IS UNDERWAY TO EXTEND THE HIGH TEMPERATURE CAPABILITY OF A NUMBER OF METALLIC ALLOY SYSTEMS AND SEVERAL NONMETALLIC ALLOY SYSTEMS. ALLOYING, DISPERSION STRENGTHENING, PRE-ALLOYED POWDER TECHNOLOGY AND THERMOMECHANICAL PROCESSING ARE MAJOR TECHNIQUES UNDER INVESTIGATION TO ENHANCE THE CAPABILITY OF VARIOUS METALLIC SYSTEMS. SPECIFIC JOINING TECHNIQUES SUCH AS SOLID STATE WELDING ARE AMONG THE PROMISING TECHNIQUES BEING STUDIED. IMPLICIT IN EACH RESEARCH AREA ARE BASIC STUDIES DESIGNED TO CONTRIBUTE TO THE UNDERSTANDING OF FUNDAMENTAL MATERIAL BEHAVIOR. THIS PROGRAM COUPLES WITH OTHER IN-HOUSE AND CONTRAC WORK UNDER RTOP'S 129-03-21, 129-03-23, AND 129-03-28.

RTOP NO. 129-03-20 TITLE: HIGH TEMPERATURE MATERIALS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: MALTZ, J. TEL. 202-962-0054  
TECHNICAL SUMMARY

NEW NICKEL - OR COBALT-BASE SUPERALLOYS, REFRACTORY METAL ALLOYS, AND CERAMIC MATERIALS ARE DEVELOPED. MECHANICAL PROPERTIES AND RESISTANCE TO CORROSION IN ENVIRONMENTS OF INTEREST ARE DETERMINED AT ROOM TEMPERATURE AND AT ELEVATED TEMPERATURES. STRENGTHENING AND DUCTILIZING MECHANISMS ARE INVESTIGATED. THE EFFECT OF PROTECTIVE COATINGS IS STUDIED. THE RELATIONSHIPS BETWEEN MICROSTRUCTURE AND PROPERTIES ARE ELUCIDATED.

RTOP NO. 129-03-21 TITLE: LIGHT ALLOYS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: RARING, R. H. TEL. 202-962-0054  
TECHNICAL SUMMARY

STRUCTURAL MATERIALS WITH HIGHER STRENGTH-TO WEIGHT RATIOS (S/W), AND THAT ARE ECONOMIC, RELIABLE, AND IN ADEQUATE SUPPLY, ARE A CONTINUING NEED FOR AEROSPACE VEHICLES. THESE NEEDS COVER TEMPERATURES FROM THE NEAR ABSOLUTE ZERO TO THE HIGHEST POSSIBLE. THE MATERIALS MUST BE COMPATIBLE WITH MANY SEVERE ENVIRONMENTS THAT CHANGE AS THE SPEEDS, FUELS, OXIDANTS, ETC. CHANGE WITH NEW MISSIONS. AMONG THE SEVERAL PROBLEMS THAT THWART THE FULL USE OF OUR HIGHEST S/W MATERIALS ARE STRESS-CORROSION CRACKING, HYDROGEN EMBRITTLEMENT, UNRELIABILITY, AND EXCESSIVE BRITTLINESS. THIS RESEARCH ATTACKS THESE PROBLEMS. APPLICATION WOULD LEAD TO LIGHTER AND MORE RELIABLE PRESSURE VESSELS FOR SPACECRAFT, PRACTICAL HYDROGEN-FUELED AIRCRAFT ENGINES, MORE RELIABLE NUCLEAR ROCKETS, STRUCTURAL APPLICATIONS OF BERYLLIUM; AND TURBOJET ENGINES THAT ARE LIGHTER IN WEIGHT, MORE RELIABLE, AND MORE EFFICIENT.

RTOP NO. 129-03-21 TITLE: LIGHT ALLOYS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO OBTAIN AN INCREASED UNDERSTANDING OF THE PROCESSING AND PHENOMENA WHICH CONTROL THE HYDROGEN EMBRITTLEMENT PROCESS. RESULTS OF THIS WORK COULD HAVE APPLICATION IN DESIGN OF VESSELS FOR HYDROGEN GAS STORAGE AND MATERIALS FOR AEROSPACE PROPULSION

RTOP NO. 129-03-21 TITLE: LIGHT ALLOYS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP IMPROVED UNDERSTANDING OF THE BEHAVIOR OF LIGHT STRUCTURAL ALLOYS UNDER THE LANDING AND ENVIRONMENTAL CONDITIONS EXPERIENCED IN ADVANCED AEROSPACE VEHICLES. OF SPECIAL INTEREST IS A BETTER UNDERSTANDING OF INTERACTIONS BETWEEN STRESSES, ENVIRONMENTS, AND EXPOSURE TIMES UNDER STATIC OR CYCLIC CONDITIONS. THE WORK INCLUDES STUDIES OF FATIGUE AND CORROSION PHENOMENA AND THEIR INTERACTIONS AND TREATS EXPERIMENTAL STUDIES SIMULATING TYPICAL FLIGHTS OF SUPERSONIC AIRCRAFT WITH GROUND-AIR-GROUND CYCLES, INVESTIGATION OF FATIGUE BEHAVIOR IN A REDUCED PRESSURE ENVIRONMENT, AND INVESTIGATION OF EMBRITTLEMENT, STRESS CORROSION, CRACK INITIATION AND PROPAGATION, AND FRACTURE OF STRUCTURAL SHEET MATERIALS IN VARIOUS ENVIRONMENTS. THE FATIGUE RESEARCH WILL INCLUDE BOTH REAL TIME AND COMPRESSED TIME TESTS TO IDENTIFY VARIABLES WHICH INFLUENCE FATIGUE BEHAVIOR MOST SIGNIFICANTLY. EFFORT WILL ALSO BE DIRECTED AT DEVELOPMENT OF ANALYTICAL MODELS THAT MAY BE USED TO PREDICT IMPACT CRATERING OF QUASI-INFINITE AND FINITE TARGETS AS WELL AS MULTIPLE PLATES, AND AT



EVALUATION OF EFFECTS OF PROCESSING VARIABLES ON THE MARTENSITIC PHASE TRANSFORMATION AND MEMORY RECOVERY CAPABILITY OF 55-NITINOL ALLOY. THESE STUDIES WILL PROVIDE THE BASIS FOR A BETTER UNDERSTANDING OF THE PRINCIPLES THAT GOVERN BEHAVIOR OF MATERIALS UNDER CONDITIONS OF INTEREST FOR STRUCTURES FOR FUTURE FLIGHT VEHICLES.

RTOP NO. 129-03-21 TITLE: LIGHT ALLOYS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: BROOKS, G. W. TEL. 205-453-1120  
TECHNICAL SUMMARY

THE WORK IN LIGHT ALLOYS WILL CENTER AROUND TWO THEMES (A) THE FRACTURE TOUGHNESS CHARACTERISTICS OF STRUCTURAL ALLOYS, AND (B) THE CORROSION EFFECTS OF OXYGEN ON SPACECRAFT STRUCTURAL ALLOYS. THE NECESSARY TESTING PROGRAM WILL BE DEVELOPED IN ORDER TO INCREASE RELIABILITY, INSURE USEABILITY OF LIGHT ALLOYS UNDER ADVERSE ENVIRONMENTAL CONDITIONS, AND TO DECREASE COST OF MANUFACTURE OF THE WORKED MATERIAL.

RTOP NO. 129-03-21 TITLE: FATIGUE, FRACTURE AND LIFE PREDICTION  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: AULT, G. M. TEL. 000-000-6387  
TECHNICAL SUMMARY

A MAJOR OBJECTIVE IS TO OBTAIN A BETTER UNDERSTANDING OF THE FAILURE OR FRACTURE MECHANISMS THAT ARE INVOLVED IN THE APPLICATION OF ADVANCED MATERIALS TO AEROSPACE MISSIONS. A SECOND MAJOR OBJECTIVE IS TO DEVELOP METHODS FOR PREDICTING THE LIFE OF SPECIMENS AND COMPONENTS WHEN THEY ARE SUBJECTED TO COMPLEX PATTERNS OF TEMPERATURES AND LOADS AS A FUNCTION OF TIME. TO ACHIEVE THESE OBJECTIVES, RESEARCH IS UNDERWAY TO EXTEND EXISTING ANALYSES AND TO DEVELOP NEW APPROACHES FOR DETERMINING THE STRESS AND STRAIN DISTRIBUTIONS IN THE VICINITY OF DISCONTINUITIES SUCH AS FLAWS OR CRACKS, AND TO UNDERSTAND THE REACTION OF AEROSPACE MATERIALS TO THESE DISCONTINUITIES WHEN SUBJECTED TO VARIOUS ENVIRONMENTAL CONDITIONS. APPROACHES ARE ALSO BEING EXAMINED FOR PREDICTING THE TIME TO THE INITIATION OF THE FIRST DETECTABLE CRACKS AS A RESULT OF MECHANICAL AND THERMAL FATIGUE AND TO PREDICTING THE PROPAGATION RATE OF THE CRACKS. EFFECTS OF CRYOGENIC AND ELEVATED TEMPERATURES ON THE FAILURE MECHANISMS ARE BEING STUDIED AS WELL AS THE EFFECT OF HIGH PRESSURE ON THE FLOW AND FRACTURE OF MATERIALS SUCH AS CHROMIUM. THIS PROGRAM COUPLES WITH OTHER IN-HOUSE AND CONTRACT WORK UNDER RTOP 126-15-18.

RTOP NO. 129-03-22 TITLE: POLYMERS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO CONDUCT FUNDAMENTAL RESEARCH

ON THE PROPERTIES AND BEHAVIOR OF POLYMERS WITH A VIEW TOWARD THEIR APPLICATION IN THE PHYSICAL AND LIFE SCIENCES AND IN SPACE TECHNOLOGY. SPECIFICALLY THIS WORK WILL DEAL WITH FORMULATION AND EVALUATION OF ABLATIVE AND FIRE-SUPPRESSION MATERIALS, MECHANISMS BY WHICH THE SPACE ENVIRONMENT CAN ALTER THE MOLECULAR STRUCTURE OF POLYMERS, THE PHOTOCHEMISTRY OF SMOG FORMATION AND POLYMERIC MEMBRANES HAVING SELECTIVE PERMEABILITY TO ORGANIC AND INORGANIC MOLECULES. APPLICATIONS FOR THIS WORK ARE IN FIELDS OF SPACECRAFT HEAT PROTECTION, FIRE SUPPRESSION, ENVIRONMENTAL EFFECTS ON MATERIALS, AIR AND WATER POLLUTION AND PURIFICATION AND NEUROPHYSIOLOGY.

RTOP NO. 129-03-22 TITLE: POLYMERS FOR FUEL TANK SEALANTS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: GOODWIN, G. TEL. 205-453-1120  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK ARE THE DEVELOPMENT OF THERMALLY STABLE FUEL RESISTANT BASE MATERIALS, THE CONVERSION OF THESE BASE MATERIALS INTO PRACTICAL FUEL TANK SEALANTS, AND THE DEVELOPMENT OF A TEST METHODOLOGY AND PROCEDURE THAT CAN BE APPLIED IN A SHORT TIME TO THESE AND OTHER SEALANTS.

RTOP NO. 129-03-22 TITLE: POLYMERS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONDUCT BASIC RESEARCH ON THE PROPERTIES AND BEHAVIOR OF POLYMERS WITH A VIEW TOWARD THEIR APPLICATION IN AEROSPACE STRUCTURES. SPECIAL EMPHASIS WILL BE PLACED ON RELATING MOLECULAR STRUCTURE TO CHEMICAL AND PHYSICAL PROPERTIES, THEREBY LAYING A BROAD FOUNDATION TO SUPPORT THE DEVELOPMENT OF MANY MATERIALS WITH DIFFERENT PROPERTIES FOR A DIVERSITY OF APPLICATIONS. NEW MATERIALS, METHODS OF FABRICATION, AND TEST EVALUATION PROCEDURES REQUIRING BOTH WIND TUNNEL AND SMALL VEHICLE FLIGHT TESTS ARE ENVISIONED. THE RESULTS WILL LEAD TO MORE EFFECTIVE MATERIALS AND METHODS OF FABRICATION OF A VARIETY OF POLYMERIC MATERIALS FOR SPACECRAFT COMPONENTS.

RTOP NO. 129-03-22 TITLE: POLYMERS  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: HEINDL, C. J. TEL. 213-354-3279  
TECHNICAL SUMMARY

THIS IS A TWO-PART PROGRAM OF FUNDAMENTAL RESEARCH ON THE ELECTRICAL AND MECHANICAL BEHAVIOR OF POLYMERS. THE TWO AREAS ARE RELATED BY THE FACT THAT LONG AND SHORT RANGE MOLECULAR MOTIONS CAN CONTROL THE PHYSICAL RESPONSE OF A POLYMER. THE ELECTRICAL PROPERTIES RESEARCH IS INTENDED TO ACHIEVE UNDERSTANDING AND CONTROL OF ELECTRONIC CONDUCTIVITY IN POLYMERIC MATRICES, WITH A LONG RANGE

GOAL OF ATTEMPTING TO CREATE A POLYMERIC SUPERCONDUCTOR. THE MECHANICAL PROPERTIES RESEARCH IS INTENDED TO DETERMINE THE MOLECULAR PARAMETERS WHICH CONTROL RHEOLOGICAL BEHAVIOR. THIS HAS BEEN SUCCESSFUL IN SIMPLE AMORPHOUS SYSTEMS WHICH ARE NOT CHEMICALLY REACTING. THE GOAL NOW IS TO EXTEND THIS WORK FIRST TO LONGER TIMES, WHERE DEGRADATION MAY SET IN, AND THEN TO SHORTER TIMES, WHERE THE MATERIAL IS GLASS-HARD. IN BOTH CASES THE GENERAL APPROACH SHOULD INVOLVE THE SYNTHESSES OF BOTH NEW AND MODIFIED POLYMERIC AND PROTOTYPE CHEMICAL STRUCTURES, THE CHARACTERIZATION OF THESE MATERIALS AND THE DETERMINATION OF CHEMICAL STRUCTURE AND PROPERTY RELATIONSHIPS. APPLICATIONS FOR THE ELECTRICAL PROPERTY EFFORT MIGHT RANGE FROM IMPROVEMENTS IN HIGH VOLTAGE INSULATION AND NEW PHOTODETECTORS TO MHD RE-ENTRY SHIELDS; FOR THE MECHANICAL PROPERTIES WORK, IMPROVED SOLID PROPELLANTS, SEALANTS FOR HIGH-SPEED AIRCRAFT AND NEW TYPES OF REINFORCED PLASTICS.

RTOP NO. 129-03-22 TITLE: POLYMERS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: ACHHAMMER, B. G. TEL. 202-962-0054  
TECHNICAL SUMMARY

BASIC RESEARCH ON POLYMERIC MATERIALS, SUCH AS PLASTICS AND ELASTOMERS, IS BEING CONDUCTED IN ORDER TO PROVIDE THE NASA WITH FUNDAMENTAL KNOWLEDGE NEEDED TO PRODUCE REQUIRED MATERIALS FOR ADVANCED AEROSPACE MISSIONS. THE RELATIONSHIPS BETWEEN CHEMICAL STRUCTURE, PHYSICAL MORPHOLOGY AND CRYOGENIC PROPERTIES OF POLYMERS ARE BEING STUDIED TO IMPROVE LOW TEMPERATURE MATERIALS. POSSIBLE SYNTHESIS OF AN ORGANIC SUPERCONDUCTOR IS BEING INVESTIGATED AS A MEANS OF OBTAINING HIGH TC MATERIALS. THE BASIC MECHANISMS OF POLYMER IGNITION AND COMBUSTION ARE BEING STUDIED TO PROVIDE THE UNDERSTANDING NEEDED TO MAKE LESS FLAMMABLE MATERIALS.

RTOP NO. 129-03-23 TITLE: COMPOSITE MATERIALS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: GANGLER, J. J. TEL. 202-962-0054  
TECHNICAL SUMMARY

THE KINETICS OF CRYSTALLIZATION OF MOLTEN BINARY AND TERNARY OXIDE SYSTEMS ARE BEING INVESTIGATED AND THE INFLUENCE OF SUCH FACTORS AS COMPLEX MOLECULE FORMATION AND ANTI-NUCLEATING AGENTS ARE BEING DETERMINED. THE EFFECT OF MICROSTRUCTURE ON THE MECHANICAL PROPERTIES OF SUCH GLASSES IS ALSO BEING EXPLORED. THE OBJECTIVE IS TO OBTAIN A BETTER UNDERSTANDING OF GLASS FORMING SYSTEMS AS A GUIDE TO THE SELECTION OF OXIDE SYSTEMS SUITABLE FOR FORMING CONTINUOUS HIGH STRENGTH, HIGH MODULUS, HIGH TEMPERATURE VITREOUS FIBERS FOR USE AS REINFORCEMENTS IN ADVANCED COMPOSITES FOR FUTURE NASA NEEDS.

RTOP NO. 129-03-23 TITLE: COMPOSITE MATERIALS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEFINE AND INVESTIGATE SUPERIOR REINFORCEMENTS AND MATRIX MATERIALS FOR FILAMENTARY COMPOSITES AND TO STUDY THE FUNDAMENTAL MECHANICAL AND CHEMICAL BEHAVIOR OF STRUCTURAL COMPOSITES. THE WORK WILL FOCUS ON INVESTIGATION OF NEW OR ADVANCED FILAMENTARY MATERIALS AND COMPOSITES TO ESTABLISH MECHANICAL PROPERTIES WITH A VIEW TOWARD THEIR STRUCTURAL APPLICATIONS IN ADVANCED AERONAUTICAL AND SPACE VEHICLES. STUDIES WILL ALSO BE MADE OF ADHESIVES AND RESINS, AND THE BONDING OF FILAMENTARY COMPOSITES TO STRUCTURAL METALS. A PORTION OF THE RESEARCH AIMED AT BASIC DEVELOPMENTS OF RESINS AND ADHESIVES WILL BE ACCOMPLISHED BY CONTRACT TO SUPPORT THE IN-HOUSE EXPERIMENTAL PROGRAM. THIS PROGRAM WILL YIELD INFORMATION ON THE FUNDAMENTAL BEHAVIOR OF ADVANCED COMPOSITES AND WILL PROVIDE A BASIS FOR SELECTING ADVANCED COMPOSITES FOR FURTHER STUDIES AIMED AT APPLICATIONS IN FLIGHT VEHICLES.

RTOP NO. 129-03-23 TITLE: COMPOSITE MATERIALS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: AULT, G. M. TEL.  
TECHNICAL SUMMARY

THE OVER-ALL OBJECTIVE OF THIS RESEARCH IS TO DEVELOP FIBER AND LAMINATE COMPOSITE MATERIALS AND COMPOSITE STRUCTURES OR COMPONENTS FOR VARIOUS AEROSPACE APPLICATIONS. BOTH PLASTIC AND METAL MATRIX COMPOSITES UNDER STUDY MUST EXHIBIT GREATER STRENGTHS, TOUGHNESS, MODULUS OF ELASTICITY, AND WHEREVER POSSIBLE, LIGHTER WEIGHT THAN USUAL BULK, MONOLITHIC ENGINEERING MATERIALS. SUPERIOR PROPERTY-TO-WEIGHT ADVANTAGES (E.G. SPECIFIC WEIGHT OR SPECIFIC MODULI) MUST BE MAINTAINED AT TEMPERATURE LEVELS OF INTEREST WHICH RANGE FROM CRYOGENIC TEMPERATURES TO OVER 2500 DEGREES F. SINCE MOST OF THE EFFORT IS ORIENTED TOWARD USE IN ADVANCED GAS TURBINE ENGINES, THE GREATEST EFFORTS ARE GEARED TOWARD INCREASING USE TEMPERATURES FOR SUCH ENGINE COMPONENTS AS FAN BLADES, COMPRESSOR BLADES, TURBINE BUCKETS, AND NOZZLE VANES. TO ACHIEVE THESE OBJECTIVES, NEW COMPOSITE MATERIALS OF BOTH PLASTIC AND METAL MATRICES ARE BEING PRODUCED. CHEMICAL SYNTHESIS OF HIGH STRENGTH-HIGH TEMPERATURE PLASTIC OR POLYMER MATRIX MATERIALS AND METALLURGICAL ALLOYING OF METAL MATRIX MATERIALS ARE UNDERWAY CONCURRENTLY WITH STUDIES TO INCREASE STRENGTH OF FIBERS, BONDING OF FIBERS TO DIFFERENT TYPES OF MATRICES, AND COMPATIBILITY BETWEEN FIBER AND MATRIX. METHODS FOR DESIGNING AND ANALYZING FILAMENTARY COMPOSITES AND FOR STRUCTURAL SYNTHESIS OF GAS TURBINE COMPONENTS WITH OPTIMIZED PROPERTIES ARE BEING DEVELOPED. IMPLICIT IN EACH RESEARCH AREA ARE FUNDAMENTAL STUDIES TO RELATE PROPERTIES OF COMPOSITES TO PROPERTIES OF THEIR CONSTITUENTS UNDER DIFFERENT CONDITIONS OF STRESS APPLICATION, TEMPERATURE, AND ENVIRONMENTS.

RTOP NO. 129-03-24 TITLE: BEARINGS, SEALS & LUBRICANTS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RTOP IS TO (1) DEFINE THE RELATIONSHIP BETWEEN THE ADHESION OF METALS AND THEIR DEGREE OF SURFACE CLEANLINESS, AND (2) TO STUDY THE DIFFUSION KINETICS AND MECHANISMS OF ADHESION AS A FUNCTION OF SURFACE CONDITION. THESE OBJECTIVES WILL BE ACCOMPLISHED THROUGH IN-HOUSE EXPERIMENTAL AND ANALYTICAL PROGRAMS. CONTACT TYPE EXPERIMENTS WILL BE CONDUCTED IN ULTRAHIGH VACUUM SYSTEMS AT VARYING DEGREES OF SURFACE CLEANLINESS, TEMPERATURE, CONTACT PRESSURE, AND TIME IN CONTACT. DURING THESE EXPERIMENTS THE ADHESION COEFFICIENTS WILL BE MEASURED AS A FUNCTION OF THE PRINCIPAL PARAMETERS. AND CONCENTRATION DISTANCE PROFILES WILL BE MEASURED TO DETERMINE DIFFUSION COEFFICIENTS AND ACTIVATION ENERGY. THIS RESEARCH WILL GIVE DEEPER INSIGHT INTO ADHESION PHENOMENA AND WILL PERMIT A BETTER EVALUATION OF THE FUNCTIONAL INTEGRITY OF MATING SPACECRAFT MATERIALS EXPOSED TO THE THERMAL/VACUUM ENVIRONMENT OF SPACE. 14. JUSTIFICATION AT THE PRESENT TIME THERE ARE NO METHODS AVAILABLE FOR PREDICTING THE ADHESION OF METALS AS A FUNCTION OF SURFACE CLEANLINESS, TEMPERATURE, CONTACT PRESSURE AND TIME IN CONTACT. METHODS FOR PREDICTING ADHESION ARE REQUIRED TO EVALUATE THE ADHESION PROBLEMS FOR THE FUTURE LONG DURATION MISSIONS. THE LONG DURATIONS MISSIONS ARE PARTICULARLY SUSCEPTIBLE TO ADHESION PROBLEMS BECAUSE MANY EXTERIOR SPACECRAFT SURFACES BECOME CLEANER WITH SPACE EXPOSURE. THE RESEARCH OUTLINED IN THIS RTOP WILL GIVE DEEPER INSIGHT INTO ADHESION PHENOMENA AND THUS PERMIT A BETTER EVALUATION OF THE FUNCTIONAL INTEGRITY OF MATING SPACECRAFT SURFACES IN SPACE. 15. TECHNICAL PLAN A. OBJECTIVES THE OBJECTIVES OF THIS RTOP IS (1) TO DEFINE THE RELATIONSHIP BETWEEN THE ADHESION OF METALS AND THEIR DEGREE OF SURFACE CLEANLINESS, AND (2) TO STUDY----

RTOP NO. 129-03-24 TITLE: BEARINGS, SEALS AND LUBRICANTS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: ANDERSON, W. J. TEL.  
TECHNICAL SUMMARY

BASIC MATERIALS AND LUBRICANTS STUDIES AS WELL AS EXPERIMENTS AND ANALYSES WITH ACTUAL COMPONENTS IN VACUUM, CRYOGENIC, INERT GAS, AND LOW VISCOSITY FLUID ENVIRONMENTS WILL BE CONDUCTED. MATERIALS STUDIES INCLUDE ATOMIC, MOLECULAR AND CRYSTALLINE AND SURFACE PHYSICS AND CHEMISTRY CONSIDERATIONS. THE POTENTIALS OF SELF-LUBRICATING MATERIALS AND FILM DEPOSITION METHODS ARE BEING EXPLORED. EXPERIMENTS AND ANALYSES OF PROMISING TYPES OF FLUID FILM BEARINGS AND SEALS FOR GAS AND LOW VISCOSITY LIQUID APPLICATIONS ARE UNDERWAY.

SEAL CONCEPTS INCLUDE THOSE WITH SELF-ACTING AND EXTERNALLY PRESSURIZED FILM GENERATION AND SELF-PUMPING VISCO SEALS. PROMISING MATERIALS FROM VACUUM STUDIES WILL BE USED FOR HUMAN HIP PROSTHESIS STUDIES AND POSSIBLE IMPLANTS. RESPONSE AND STABILITY ANALYSES OF FLEXIBLE ROTOR-BEARING SYSTEMS ARE BEING CONDUCTED TO ESTABLISH DESIGN TECHNOLOGY FOR FUTURE HIGH SPEED TURBOMACHINERY.

RTOP NO. 129-03-24 TITLE: BEARINGS, SEALS AND LUBRICANTS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: MALTZ, J. TEL. 202-962-0054  
TECHNICAL SUMMARY

NEW BEARING MATERIALS, LUBRICANTS AND MECHANICAL CONCEPTS APPLICABLE TO THE RELIABLE OPERATION OF BEARINGS AND SEALS IN SPECIAL ENVIRONMENTS DICTATED BY NASA'S MISSIONS ARE UNDER DEVELOPMENT.

RTOP NO. 129-03-25 TITLE: EXTRATERRESTRIAL MATERIALS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: GANGLER, J. J. TEL. 202-962-0054  
TECHNICAL SUMMARY

THIS WORK IS BEING CARRIED OUT BY THE BUREAU OF MINES UNDER A MULTIDISCIPLINARY GRANT. IT INVOLVES A COMPREHENSIVE PROGRAM OF BASIC RESEARCH ON THE PROPERTIES AND BEHAVIOR OF ROCKS AND MINERALS, SO THAT KNOWLEDGE WILL BE AVAILABLE WHEN NEEDED FOR THE DEVELOPMENT OF EXTRATERRESTRIAL MINING AND PROCESSING TECHNOLOGY. A SECOND PROJECT, TO DETERMINE THE ADHESION MECHANISMS FOR CLEAVED SILICATES, WILL BE COMPLETED IN FY 1970.

RTOP NO. 129-03-25 TITLE: EXTRATERRESTRIAL MATERIALS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: GANGLER, J. J. TEL. 205-453-1120  
TECHNICAL SUMMARY

A STUDY OF THE BASIC MODES OF HEAT TRANSFER IN PARTICULATE MATERIALS WILL BE MADE. AN EXPERIMENTAL STUDY OF THE EFFECTS OF VACUUM CONDITIONING ON THE PHYSICAL PROPERTIES OF SELECTED MATERIALS WILL BE PERFORMED. PHYSICAL PROPERTIES AND ENGINEERING BEHAVIOR OF MATERIALS UNDER VARIOUS SIMULATED LUNAR AND PLANETARY ENVIRONMENTAL CONDITIONS WILL BE INVESTIGATED. THESE INVESTIGATIONS ARE NEEDED IN ORDER TO DEVELOP AND BUILD SKILL IN INTERPRETATION OF FINDINGS, KNOWLEDGE OF THE UNKNOWN, AND A MODE OF OPERATION AS RELATED TO EXTRATERRESTRIAL SOURCE MATERIALS. THE WORK WILL BE DONE IN-HOUSE.

RTOP NO. 129-03-25 TITLE: EXTRATERRESTRIAL MATERIALS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO OBTAIN AN INCREASED UNDERSTANDING OF THE EFFECTS OF HYPERVELOCITY IMPACTS OF ROCKS AND MINERALS. RESULTS COULD FIND APPLICATION IN THE ANALYSIS AND INTERPRETATIONS OF LUNAR AND OTHER EXTRATERRESTRIAL MATERIALS.



RTOP NO. 129-03-26 TITLE: ADVANCED FORMING AND PROCESSING  
ORGANIZATION: GODDARD SPACE FLT. CENTER  
MONITOR: PILTCH, A. TEL. 301-982-5053  
TECHNICAL SUMMARY

CHEMICAL VAPOR DEPOSITION, ION BEAM POLISHING, ELECTROPOLISHING AND HIGH ENERGY FORMING ARE BEING INVESTIGATED AS METHODS FOR ACHIEVING HIGHLY ACCURATE AND STABLE OPTICAL ELEMENTS. THE EFFECTS OF SURFACE FINISH TREATMENTS ON THE STRENGTH OF CERAMIC MATERIALS ARE BEING STUDIED WITH A VIEW TO IMPROVING MECHANICAL PROPERTIES. LIGHTWEIGHT ALLOYS ARE BEING STUDIED FOR USE AS STRUCTURAL MATERIALS IN AEROSPACE APPLICATIONS IN GENERAL AND FOR SUPPORTING OPTICAL ELEMENTS IN PARTICULAR. THE PIEZOELECTRIC EFFECT IS BEING INVESTIGATED AS A POSITIONING METHOD FOR GENERATING AND TESTING ACCURATE ASPHERIC ELEMENTS.

RTOP NO. 129-03-26 TITLE: ADVANCED FORMING AND PROCESSING  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: PILTCH, A. TEL. 205-453-1119  
TECHNICAL SUMMARY

THE MATERIALS PROCESSING AND MANUFACTURING IN SPACE PROGRAM PLAN IS AN INTERDISCIPLINARY EFFORT IN THE AREAS OF 1) MATERIALS SCIENCE, 2) MANUFACTURING TECHNOLOGY CULMINATING IN THE ADVANCEMENT OF MATERIALS SCIENCE AND THE PRODUCTION OF VALUABLE ITEMS IN EARTH ORBIT, AND 3) INDUSTRIAL APPLICATION. THIS RTOP RELATES TO THE MATERIALS SCIENCE ASPECT OF THE TOTAL PROGRAM AND IS PRESENTLY FOUNDED ON GROUND BASED STUDIES, BOTH IN-HOUSE AND CONTRACTOR, TO IDENTIFY THE MECHANISMS ASSOCIATED WITH GRAVITY SENSITIVE PROCESSES. THE REPORT OF THE 1968 WINTER STUDY ON USES OF MANNED SPACE FLIGHT SAID, "THE INITIAL EMPHASIS SHOULD BE UPON RESEARCH TO UNDERSTAND HOW MATERIALS BEHAVE DURING ZERO-G PROCESSING AND TO IDENTIFY NEW MATERIALS AND FABRICATION METHODS TO BE USED LATER." A LOGICAL, WELL-PLANNED, COHERENT RESEARCH PROGRAM IS BEING INITIATED TOWARD THE UNDERSTANDING OF SPACE ENVIRONMENTAL EFFECTS ON BASIC MECHANISMS AS WELL AS THE CHARACTERIZATION OF MATERIALS AND THEIR PROCESSES. THIS EVOLUTIONARY PROGRAM HAS AS ITS BEGINNING, STUDIES TO, 1) ANALYZE THE ROLE OF GRAVITY ON SOLIDIFICATION AND CRYSTAL GROWTH, 2) ANALYTICALLY INVESTIGATE CRYSTAL WHISKER GROWTH IN A ZERO-G ENVIRONMENT, 3) DETERMINE PHASE CHANGE (SOLIDIFICATION) PROCESS TO DEFINE FUNDAMENTAL PARAMETERS MOST AFFECTED BY ZERO-G, 4) INVESTIGATE THE EFFECTS OF ZERO-G ON MATERIALS PROPERTIES, 5) DETERMINE MATERIALS DOSAGING PROBLEMS, 6) DEFINE POSITIONING, TRANSPORTING, SPIN, AND AGITATING DEVICES AND, 7) EVALUATE SEPARATION AND PURIFICATION TECHNIQUES. MSFC WILL ALSO, 1) CONDUCT A THEORETICAL INVESTIGATION OF GAS MANAGEMENT IN ZERO-G BY MATHEMATICAL MODELING AND, 2) CONDUCT DROP TOWER TESTS ON CANDIDATE MATERIALS FOR METALS FORMING AND SHAPING EXPERIMENTS.

RTOP NO. 129-03-28 TITLE: SURFACE REACTIONS AND PROTECTION  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: AULT, G. M. TEL. 000-000-6387  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS WORK ARE TO IDENTIFY THE SURFACE REACTIONS THAT OCCUR IN THE HOT GAS ENVIRONMENT OF GAS TURBINE ENGINES AND IN LIQUID ALKALI METALS FOR ADVANCED SPACE POWER SYSTEMS, TO ASSESS THE EXTENT OF MATERIAL DEGRADATION RESULTING FROM THESE REACTIONS AND TO PROVIDE PROTECTION FROM SUCH REACTIONS. PROTECTION MAY TAKE THE FORM OF PROTECTIVE COATINGS OR MAY INVOLVE ALLOY OR ENVIRONMENTAL MODIFICATIONS THAT INHIBIT REACTION. BASIC STUDIES WILL BE CONDUCTED TO PROVIDE AN UNDERSTANDING OF CORROSION MECHANISMS IN ORDER TO GUIDE EXPERIMENTATION AIMED AT PROVIDING PROTECTION. FOR EXAMPLE, IN STUDIES OF THE HOT SALT STRESS CORROSION OF TITANIUM ALLOYS, THE ROLES OF ENVIRONMENTAL CONSTITUENTS SUCH AS HYDROGEN, WATER VAPOR AND HALOGENS WILL BE EXAMINED. IN OXIDATION STUDIES, THE MECHANISM BY WHICH OXIDES BECOME NON-PROTECTIVE WILL BE STUDIED. IN LIQUID METAL CORROSION STUDIES, THE ROLES OF INTERSTITIAL IMPURITIES AND GETTERING ELEMENTS WILL BE ELUCIDATED. WHERE APPLICABLE, PROTECTIVE COATINGS WILL BE APPLIED AND THEIR EFFECTIVENESS STUDIED AS A FUNCTION OF TEMPERATURE, TIME AND ENVIRONMENTAL CONSTITUENTS.

RTOP NO. 129-03-30 TITLE: REFRACTORY METAL HEAT SHIELDS FOR SPACE SHUTTLE VEHICLES

ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: AULT, G. M. TEL. 216-433-4000  
TECHNICAL SUMMARY

THIS PROGRAM INVOLVES RESEARCH AND DEVELOPMENT ON COATED REFRACTORY METALS FOR VERY HIGH TEMPERATURE HEAT SHIELDS OF REUSABLE RE-ENTRY VEHICLES. THE EMPHASIS IS PLACED ON PROVIDING THE TECHNOLOGY TO MEET THE MULTI-MISSION, MINIMUM REFURBISHING REQUIREMENTS OF SPACE SHUTTLE VEHICLES. EFFORTS TO IMPROVE COATING PROTECTION AND RELIABILITY ARE SUPPORTED BY THE DEVELOPMENT OF APPROPRIATE COATING COMPOSITIONS, PROCESS SCALE-UP, AND DETECTION AND FIELD REPAIR OF COATING DEFECTS. THE STUDIES WOULD BE CARRIED TO THE POINT OF LABORATORY EVALUATION OF COATED MATERIALS AND REPRESENTATIVE HEAT SHIELD TEST SPECIMENS UNDER SIMULATED RE-ENTRY EXPOSURE CONDITIONS. THE PROGRAM WOULD DEVELOP THE NECESSARY COATING TECHNOLOGY BUT WOULD NOT PRODUCE OR EVALUATE FULL SCALE HARDWARE. SUCH FULL SCALE HEAT SHIELD PRODUCTION AND TESTING WOULD BE CONDUCTED BY OTHER CENTERS SUCH AS LANGLEY.

RTOP NO. 129-03-31 TITLE: DEVELOPMENT OF NI-CR-THO<sub>2</sub> FOR SPACE SHUTTLE VEHICLES

ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: AULT, G. M. TEL. 216-433-4000  
TECHNICAL SUMMARY

THIS PROGRAM INVOLVES THE DEVELOPMENT OF THE DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOY (NI-CR-THO<sub>2</sub>) FOR USE IN THE HEAT SHIELD OF PROPOSED SPACE SHUTTLE VEHICLES. THE OBJECTIVES OF THE

PROGRAM ARE: 1. TO ASSURE THAT NI-CR-THO2 IS THE BEST MATERIAL AND MEETS ALL THE REQUIREMENTS FOR THIS APPLICATION. 2. TO IMPROVE AND SCALE-UP PRESENT METHODS OF PRODUCING NI-CR-THO2 SHEET TO ATTAIN BETTER QUALITY, MORE CONSISTANT PROPERTIES, BETTER OXIDATION RESISTANCE, AND LARGER SHEET SIZES. 3. TO DEVELOP RELIABLE METHODS FOR FORMING AND JOINING NI-CR-THO2 SHEET INTO HEAT SHIELD CONFIGURATIONS. 4. TO DEVELOP AN ALTERNATE PROCESS FOR PRODUCING NI-CR-THO2. THE WORK REQUIRED TO MEET THESE OBJECTIVES WILL BE DONE PRIMARILY THROUGH CONTRACTS WITH QUALIFIED INDUSTRIAL LABORATORIES. THE SCOPE OF THE PROGRAM IS LIMITED TO MEETING THE STATED OBJECTIVES. THE PROGRAM IS DESIGNED TO ASSURE THAT THE MATERIAL AND NECESSARY TECHNOLOGY WILL BE AVAILABLE FOR THE FABRICATION OF ACTUAL VEHICLE HEAT SHIELDS. IT DOES NOT INCLUDE FABRICATION OF THE ACTUAL VEHICLE HEAT SHIELDS.

RTOP NO. 129-03-40 TITLE: SURFACE PHYSICS AND CHEMISTRY  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO OBTAIN AN INCREASED UNDERSTANDING OF PHYSICAL, CHEMICAL AND MECHANICAL SURFACE PROCESSES. RESULTS OF THIS WORK WILL FIND APPLICATION IN SUCH AREAS AS ELECTRONICS, CORROSION AND MATERIALS PROCESSING.

RTOP NO. 129-03-40 TITLE: SURFACE PHYSICS AND CHEMISTRY  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: GOODWIN, G. TEL. 205-453-1120  
TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL STUDIES ARE BEING PERFORMED IN ORDER TO AUGMENT THE UNDERSTANDING OF VARIOUS ATOMIC, IONIC AND ELECTRONIC INTERACTIONS AT GAS-SOLID INTERFACES. IN PARTICULAR, THESE INVESTIGATIONS TAKE ADVANTAGE OF SUCH METHODS AS LOW ENERGY ELECTRON DIFFRACTION (LEED), AUGER ELECTRON SPECTROSCOPY, FIELD EMISSION AND FIELD ION MICROSCOPY, FLASH FILAMENT TECHNIQUES, WORK FUNCTION MEASUREMENTS BY MODIFIED RETARDING POTENTIAL METHODS, ETC. BESIDES THE BASIC TECHNICAL KNOWLEDGE, THE APPROACH OF THESE INVESTIGATIONS ALSO SEEKS "FIRST HAND" COMPARISON CAPABILITY BETWEEN THE STRENGTH AND WEAKNESS OF THE EXPERIMENTAL TECHNIQUES JUST MENTIONED. THE CURRENT STUDY DEALS WITH ACTIVATED NITROGEN ADSORPTION ON SINGLE CRYSTALLINE NICKEL SURFACES, OXYGEN AND HYDROGEN ADSORPTION ON TUNGSTEN AND OTHER REFRACTORY METALS, INCLUDING IRIIDIUM-TUNGSTEN ALLOYS. EPITAXIAL GROWTH OF ADSORBED LAYERS, INCLUDING THE FORMATION OF MICROSCOPIC PROTRUSIONS, IS BEING STUDIED WITH FIELD EMISSION, FIELD ION MICROSCOPY, AND A COMBINATION OF THE TWO MODES.

RTOP NO. 129-03-40 TITLE: SURFACE PHYSICS AND CHEMISTRY  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: MACRAKIS, M. TEL. 617-494-2474  
TECHNICAL SUMMARY

TO DEVELOP INCREASED UNDERSTANDING OF METALLIC, SEMICONDUCTOR AND SUPERCONDUCTING SURFACES TO CORRELATE ELECTRONIC PROPERTIES WITH ATOMIC STRUCTURE OF CRYSTALLINE SURFACES AND THE FUNDAMENTAL MECHANISMS OF PHYSICAL AND CHEMICAL SURFACE PROCESSES. TO CHARACTERIZE CLEAN SURFACES, SURFACE CONTAMINATION, IMPURITIES AND SUPERSTRUCTURES THROUGH THE APPLICATION OF LOW ENERGY ELECTRON DIFFRACTION TECHNIQUES (LEED). TO IMPROVE UNDERSTANDING OF SURFACE STATES, SURFACE PLASMONS, THERMIONIC AND PHOTOELECTRIC EMISSION, THE INITIATION OF EPITAXIAL GROWTH, CHEMISORPTION, GAS AND PLASMA SURFACE INTERACTIONS, ELECTRON SCATTERING FROM SURFACES, PENETRATION OF ELECTRONS IN SURFACES, AND THERMODYNAMIC PROPERTIES OF SURFACES

RTOP NO. 129-03-40 TITLE: SURFACE PHYSICS AND CHEMISTRY  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: NASH, R. R. TEL. 202-962-6891  
TECHNICAL SUMMARY

THIS RESEARCH SEEKS INCREASED FUNDAMENTAL UNDERSTANDING OF THE RELATIONSHIP BETWEEN ELECTRONIC AND ATOMIC STRUCTURE OF SOLIDS AND THEIR PHYSICAL, CHEMICAL AND MECHANICAL SURFACE BEHAVIOR. SPECIFIC SURFACE-CONTROLLED MATERIALS PROPERTIES OF INTEREST ARE ELECTRON AND ION EMISSION, SEMICONDUCTOR SURFACE BEHAVIOR, NUCLEATION AND GROWTH OF THIN FILMS AND CRYSTALS, ADSORPTION, EVAPORATION, OXIDATION, CORROSION, FRICTION AND WEAR AND INITIATION OF FRACTURE. THE OVERALL GOAL IS TO OBTAIN BETTER UNDERSTANDING OF MECHANISMS OF BEHAVIOR FOR IMPROVED TECHNICAL CONTROL OVER INTERFACIAL REACTIONS IN MATERIALS OF IMPORTANCE IN AERONAUTICS AND SPACE.

RTOP NO. 129-03-41 TITLE: THIN FILMS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: WEINBERG, I. TEL. 202-963-3924  
TECHNICAL SUMMARY

THIS RESEARCH SEEKS INCREASED UNDERSTANDING OF THE BASIC MECHANISMS OF GROWTH AND DETERIORATION AND THE FUNDAMENTAL RELATIONSHIPS BETWEEN STRUCTURE AND ELECTRONIC PROPERTIES OF THIN FILMS. INFORMATION OBTAINED FROM THIS PROGRAM WILL CONTRIBUTE SIGNIFICANTLY TOWARDS ACHIEVING MORE EFFICIENT OPERATION OF ELECTRONIC DEVICES BASED ON THIN FILM TECHNOLOGY. INVESTIGATIONS ARE CONDUCTED, AIMED AT UNDERSTANDING THE BASIC MECHANISMS OF ELECTRON AND MATTER TRANSPORT IN THIN FILMS AND THE RELATIONSHIPS BETWEEN FILM STRUCTURE AND TRANSPORT PROPERTIES. MECHANISMS OF FILM DETERIORATION ARE INVESTIGATED AN EXAMPLE BEING THE PHENOMENA OF FAILURE INDUCING VOID FORMATION DUE TO ELECTROTRANSPORT AT HIGH CURRENT DENSITIES. FILMS ARE CHARACTERIZED WITH RESPECT TO IMPURITIES CRYSTAL STRUCTURE, IMPERFECTIONS AND SIZE TO PROVIDE DETAILED INFORMATION FOR USE IN RELATING TRANSPORT PHENOMENA TO THIN FILM PROPERTIES. MECHANISMS OF FILM GROWTH ARE INVESTIGATED IN ORDER TO IMPROVE PERFORMANCE AND

**ATTAIN INCREASED PERFECTION IN THIN FILMS.**

**RTOP NO. 129-03-41 TITLE: THIN FILM RESEARCH**  
**ORGANIZATION: ELECTRONICS RESEARCH CENTER**  
**MONITOR: WARSCHAUER, D. M. TEL. 617-494-2510**  
**TECHNICAL SUMMARY**

THIN FILMS OF ELECTRONICALLY ACTIVE MATERIALS ARE IMPORTANT BECAUSE THEY FORM THE BASIS FOR MANY DEVICES, COMPONENTS, AND TECHNIQUES. THE DEPOSITION OF A STABLE, CRYSTALLOGRAPHY PERFECT, PURE FILM ON A SUBSTRATE INVOLVES MANY PARAMETERS OF THE ENVIRONMENT IN WHICH THE FILM IS DEPOSITED, THE SUBSTRATE ON WHICH IT IS DEPOSITED, AND THE SOURCES FROM WHICH THE ATOMS TO FORM THE FILM ARE DERIVED. IN THIS WORK, AN IMPROVED UNDERSTANDING OF THESE PARAMETERS AND THE METHODS BY WHICH FILMS BECOME COHERENT LAYERS IS SOUGHT AS WELL AS INCREASED UNDERSTANDING OF THE FUNDAMENTAL RELATIONSHIPS BETWEEN STRUCTURE AND THE ELECTRONIC PROPERTIES OF THIN FILMS. FILMS ARE DEPOSITED UNDER A VARIETY OF CONDITIONS ON A RANGE OF SUBSTRATES AND THE RESULTANT LAYERS ARE EXAMINED MICROSCOPICALLY, ELECTRONICALLY, BY X-RAY, ELECTRON DIFFRACTION, AND BY STILL OTHER TECHNIQUES. ELECTRICAL TRANSPORT PROPERTIES AND MEANS OF MAKING ELECTRICAL CONTACT ARE OF PARTICULAR INTEREST. IN SITU DEPOSITION IN AN ELECTRON MICROSCOPE WILL BE USED FOR A DETAILED ATOMIC ANALYSIS OF THE KINETICS OF DEPOSITION. AN ATTEMPT IS MADE TO CORRELATE RESULTS WITH THEORY. THE WORK IS EXPECTED TO LEAD TO THIN FILM MATERIALS AND CONFIGURATIONS WHICH THE MORE STABLE, REPRODUCIBLE, AND BETTER SUITED FOR ELECTRONIC DEVICES AND COMPONENTS.

**RTOP NO. 129-03-42 TITLE: PHYSICS & CHEMISTRY OF SOLIDS**  
**ORGANIZATION: LEWIS RESEARCH CENTER**  
**MONITOR: LAD, R. A. TEL. 216-433-4000**  
**TECHNICAL SUMMARY**

**OBJECTIVE:** TO OBTAIN AN INCREASED UNDERSTANDING OF THE BASIC PROPERTIES OF THE SOLID STATE, BOTH BULK AND SURFACE, WITH PARTICULAR EMPHASIS ON THE ROLE OF ELECTRONIC AND MAGNETIC PROPERTIES, ATOMIC STRUCTURE AND CHEMICAL REACTIVITY IN THE DETERMINATION OF PHYSICAL, CHEMICAL AND MECHANICAL PROPERTIES. THE PARTICULAR ASPECTS OF THE RESEARCH ARE DESIGNED TO APPLY TO MATERIALS PREPARATION AND TO THE CONTROL OF PHYSICAL PHENOMENA IN MATERIALS OF STRUCTURAL AND ELECTRONIC IMPORTANCE TO NASA. **APPROACH:** PROGRAMS PERTINENT TO DIFFUSION CONTROLLED PHENOMENA SUCH AS MECHANICAL DEFORMATION, THERMAL STABILITY AND RADIATION DAMAGE WILL INCLUDE THEORETICAL AND EXPERIMENTAL STUDIES OF DIFFUSION AND THE DEFECT STRUCTURE IN METALS, INTERNAL FRICTION AND RESISTIVITY STUDIES OF RADIATION DAMAGED METALS, AND STUDIES OF THE NATURE OF SURFACE DEFECTS USING TECHNIQUES SUCH AS EPR, GAS ABSORPTION AND ELECTRON BOMBARDMENT. PROGRAMS WHICH APPLY TO PHENOMENA RELATED TO ELECTRONIC AND MAGNETIC PROPERTIES WILL INCLUDE DEVELOPMENT OF MAGNETIC THEORY FOR PURE METALS AND ALLOYS, AND THE MEASUREMENT OF MAGNETIC PROPERTIES USING TECHNIQUES SUCH AS MAGNETIC SUSCEPTIBILITY, MAGNETOSTRICTION, NEUTRON DIFFRACTION AND MOSSBAUER SPECTROSCOPY. PROGRAMS PERTINENT TO CHEMICAL BOND

CONTROLLED PROPERTIES SUCH AS THERMAL AND HIGH VACUUM STABILITY, HYDROGEN EMBRITTLEMENT IN METALS, ELECTRICAL STABILITY OF INSULATORS AT HIGH TEMPERATURE AND METAL PURITY WILL INCLUDE MASS SPECTROMETRIC STUDIES OF HIGH TEMPERATURE DECOMPOSITION OF REFRACTORY COMPOUNDS, ELECTRICAL CONDUCTIVITY AND DIFFUSION STUDIES IN HIGH TEMPERATURE ELECTRICAL INSULATORS, EPR STUDIES OF INTERACTION OF OXYGEN WITH METAL AND OXIDE SURFACES, ELECTRICAL RESISTIVITY AND MECHANICAL PROPERTIES DETERMINATIONS ON HYDROGEN LOADED TITANIUM, AND STUDIES OF HIGH PURITY METAL PREPARATION BY THE USE OF HIGH ENERGY ELECTRON IRRADIATION OF SOLUTIONS.

RTOP NO. 129-03-42 TITLE: PHYSICS AND CHEMISTRY OF SOLIDS  
ORGANIZATION: AMES RESEARCH CENTER

MONITOR: GOODWIN, G. TEL. 415-961-2265

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO OBTAIN AN INCREASED UNDERSTANDING OF INFLUENCE OF THE SPACE ENVIRONMENT ON THE DEGRADATION OF MATERIALS. RESULTS OF THIS WORK WILL BE USEFUL IN THE DESIGN OF SPACECRAFT AND SPACECRAFT SYSTEMS.

RTOP NO. 129-03-42 TITLE: PHYSICS AND CHEMISTRY OF SOLIDS  
ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: WARSCHAUER, D. M. TEL. 617-494-2510

TECHNICAL SUMMARY

STUDIES ARE CONDUCTED TO PROVIDE AN INCREASED UNDERSTANDING OF THE PHYSICS AND CHEMISTRY OF THE SOLID STATE WITH EMPHASIS ON THE ROLE OF ATOMIC AND LATTICE STRUCTURES IN DETERMINING THE PHYSICAL, CHEMICAL, MECHANICAL, ETC. PROPERTIES OF METALS, ALLOYS, INORGANIC COMPOUNDS AND MOLECULAR SOLIDS. BOTH THEORETICAL AND EXPERIMENTAL EFFORTS ARE DIRECTED TOWARD THE COLLABORATIVE SUPPORT OF MATERIALS SYNTHESIS AND CRYSTAL GROWTH ACTIVITIES AND TOWARD THE DEVELOPMENT OF FURTHER KNOWLEDGE ABOUT MATERIALS' PROPERTIES AND PHYSICAL PHENOMENA IN SOLIDS. ALSO INSTRUMENTS AND TECHNIQUES FOR THE INVESTIGATION AND CHARACTERIZATION OF MATERIALS ARE DEVELOPED AS WARRANTED. THIS RESEARCH SEEKS A BROAD BASE OF NEW KNOWLEDGE OF MATERIALS BEHAVIOR APPLICABLE TO THE PREPARATION OF, UNDERSTANDING OF THE PHYSICAL PHENOMENA IN, MATERIALS OF STRUCTURAL AND ELECTRONIC IMPORTANCE IN NASA MISSIONS.

RTOP NO. 129-03-42 TITLE: PHYSICS AND CHEMISTRY OF SOLIDS  
ORGANIZATION: NASA HEADQUARTERS

MONITOR: NASH, R. R. TEL. 202-962-6891

TECHNICAL SUMMARY

THIS RESEARCH SEEKS INCREASED SCIENTIFIC UNDERSTANDING OF THE BASIC PROPERTIES OF MATERIALS OF STRUCTURAL AND ELECTRONIC IMPORTANCE TO NASA MISSIONS. BROADLY-BASED ATTENTION IS GIVEN TO THE RELATIONSHIP BETWEEN ELECTRONIC, ATOMIC AND MOLECULAR STRUCTURE OF SOLIDS AND THEIR PHYSICAL, CHEMICAL AND MECHANICAL PROPERTIES.



CURRENT RESEARCH EMPHASIZES INVESTIGATION OF ATOMIC BONDING, CRYSTAL DEFECT STRUCTURE, THERMODYNAMICS AND KINETICS OF SOLID STATE REACTIONS, DIFFUSION, PHASE TRANSFORMATIONS, MECHANICAL PROPERTIES AND STRENGTHENING MECHANISMS AND ENVIRONMENT-SENSITIVE BEHAVIOR OF MATERIALS. NEW KNOWLEDGE FROM THESE STUDIES WILL CONTRIBUTE TO THE DESIGN OF NEW MATERIALS AND TO THE IMPROVEMENT OF EXISTING ONES FOR APPLICATIONS IN AERONAUTICS AND SPACE TECHNOLOGY.

RTOP NO. 129-03-43 TITLE: PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS

ORGANIZATION: NASA HEADQUARTERS

MONITOR: WEINBERG, I. TEL. 202-963-3924

TECHNICAL SUMMARY

THIS RESEARCH IS AIMED AT DETERMINING THE BASIC RELATIONSHIPS BETWEEN ELECTRONIC AND DEFECT STRUCTURES OF MATERIALS AND THEIR POTENTIALLY USEFUL ELECTRONIC PROPERTIES. INCREASED UNDERSTANDING IS SOUGHT IN ORDER TO DETERMINE THE BEST DIRECTIONS TO FOLLOW IN OBTAINING IMPROVED EXISTING, AND NEW, MATERIALS FOR ELECTRONIC APPLICATIONS. EXPERIMENTAL AND THEORETICAL STUDIES OF ELECTRONIC STRUCTURE, DEFECT STATES AND TRANSPORT, MAGNETIC, SUPERCONDUCTING, DIELECTRIC, SEMICONDUCTING AND INSULATING PROPERTIES ARE UTILIZED IN OBTAINING AN UNDERSTANDING OF MATERIALS FOR USE IN ELECTRONIC DEVICES. EMPHASIS IS GIVEN TO STUDIES ON MATERIALS PREPARED IN SINGLE CRYSTAL, POLYCRYSTALLINE AND AMORPHOUS FORMS. AN UNDERSTANDING OF MATERIALS GROWTH PARAMETERS IS RELATED TO ELECTRONIC PROPERTIES IN BOTH IMPROVED AND NEW MATERIALS.

RTOP NO. 129-03-43 TITLE: PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3285

TECHNICAL SUMMARY

EXPERIMENTAL AND THEORETICAL STUDIES ARE CONDUCTED ON THE RELATIONSHIP BETWEEN THE ATOMIC, MOLECULAR, AND MORPHOLOGICAL STRUCTURE OF MATERIALS AND THEIR ELECTRONIC PROPERTIES. IN THESE STUDIES, DATA ARE ACQUIRED ON SEMICONDUCTORS AND DIELECTRIC MATERIALS WHICH WILL BE OF USE IN THE DESIGN OF NEW DEVICES AND COMPONENTS HAVING STABILITIES AND LIFETIMES CONSISTENT WITH PRESENT AND FUTURE MISSION REQUIREMENTS. OF NECESSITY, STUDIES OF THE PROPERTIES FOR ELECTRONIC APPLICATIONS COVER A WIDE RANGE OF DISCIPLINES AND APPROACHES. THEY INCLUDE DETERMINATION OF THE INFLUENCE OF ELECTROMAGNETIC AND LASER RADIATION ON ION-IMPLANTED AND DIFFUSION-DOPED CRYSTALS, INQUIRY INTO CHARGE TRANSPORT PHENOMENA IN POLYMERS, AND INVESTIGATION OF THE EFFECTS OF ALLOY STOICHIOMETRY AND GRAIN BOUNDARY INTERACTIONS ON THE BEHAVIOR OF DIELECTICS.

RTOP NO. 129-03-43 TITLE: PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS

ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: WARSCHAUER, D. M. TEL. 617-494-2510

TECHNICAL SUMMARY

RESEARCH IS PERFORMED TO DEVELOP NEW ELECTRONIC MATERIALS AND TO ADAPT AND/OR DEVELOP SUITABLE METHODS FOR SYNTHESIS AND CRYSTAL GROWTH AS REQUIRED. INVESTIGATIONS COVER THE BROAD SCOPE OF MATERIALS OF CURRENT INTEREST IN ELECTRONIC APPLICATIONS: SEMICONDUCTORS, DIELECTRICS (INCLUDING FERROELECTRICS, PIEZOELECTRICS, ETC.), ELECTRO-OPTIC MATERIALS, SUPERCONDUCTORS, MAGNETIC MATERIALS, ETC. ACTIVITIES INCLUDE THE PREPARATION, CHARACTERIZATION, AND CORRELATION OF PROPERTIES WITH PREPARATIVE CONDITIONS OF MATERIALS SELECTED ON THE BASIS OF SCIENTIFIC OR TECHNOLOGICAL SIGNIFICANCE. RESULTANT MATERIALS ARE EVALUATED ON A CONTINUING BASIS FOR POSSIBLE UTILITY IN ELECTRONIC COMPONENTS AND DEVICES. FUNDAMENTAL RESEARCH ON THE BASIC RELATIONSHIP BETWEEN THESE MATERIALS AND THEIR POTENTIALLY USEFUL ELECTRONIC PROPERTIES IS CONDUCTED.

RTOP NO. 129-03-43 TITLE: PROPERTIES OF MATERIALS FOR ELECTRONIC APPLICATIONS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: WARSCHAUER, D. M. TEL. 205-453-1120

TECHNICAL SUMMARY

THEORETICAL AND EXPERIMENTAL STUDIES ARE USED TO BETTER UNDERSTAND THE EFFECTS OF ELECTROMAGNETIC AND PARTICULATE IRRADIATION ON THE OPTICAL ELECTRONIC AND MAGNETIC PROPERTIES OF INORGANIC SEMICONDUCTORY. THE NEED FOR A BETTER DEFINITION OF THE DAMAGE MECHANISMS AND THE FORMULATION OF A MODEL TO INDICATE DAMAGE AND IMPURITY SITE WITHIN THE CRYSTALS, IS RECOGNIZED AND WE WILL PURSUE AND ACQUIRE A BETTER UNDERSTANDING OF THE PHENOMENA.

RTOP NO. 129-04-20 TITLE: MATHEMATICS

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: HEINDL, C. J. TEL. 213-354-3279

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS TASK ARE: TO CONDUCT RESEARCH IN STATISTICAL ESTIMATION THEORY, OPTIMAL CONTROL THEORY, APPLIED MATHEMATICS, AND COMPUTER SCIENCE; TO DEVELOP AND BRING TO BEAR ON SCIENTIFIC AND ENGINEERING PROBLEMS AT JPL NEW AND NOVEL SOUND CONTEMPORARY PRINCIPLES OF NUMERICAL ANALYSIS; AND TO FURTHER DEVELOP THE NOVEL MATHEMATICAL TECHNIQUES AND METHODS DEVISED BY THE LABORATORY'S THEORETICAL PHYSICS GROUP FOR THE SOLUTION OF PARTICULAR PROBLEMS IN THEORETICAL PHYSICS, TO THE POINT WHERE THEY BECOME USEFUL MATHEMATICAL TOOLS IN THE ANALYSIS AND SOLUTION OF ENTIRE CLASSES OF SCIENTIFIC AND ENGINEERING PROBLEMS. STATISTICAL ESTIMATION STUDIES WILL CONTINUE IN THE SEQUENTIAL ESTIMATION OF LINEAR AND NONLINEAR CORRELATED STOCHASTIC VARIABLES ASSOCIATED WITH NON-STATIONARY RANDOM PROCESSES, DATA COMPRESSION STUDIES AND STUDIES

IN RECURSIVE UPDATING METHODS FOR ORBIT DETERMINATION PROBLEMS. PARTICULAR ATTENTION WILL BE PAID TO TECHNIQUES CAPABLE OF PERFORMING NON-LINEAR ESTIMATION IN NEAR REAL-TIME. STUDIES WILL CONTINUE IN STOCHASTIC OPTIMAL CONTROL AND NEIGHBORING OPTIMAL CONTROL. RESEARCH WILL CONTINUE ON SEMI-ANALYTICAL METHODS FOR INTEGRATION OF ORDINARY DIFFERENTIAL EQUATIONS. RESEARCH WILL CONTINUE IN NUMERICAL ANALYSIS. WORK IS BEING DONE TO DEVELOP AND ANALYZE GENERAL COMPUTER-ORIENTED ALGORITHMS, AND LECTURES IN NUMERICAL ANALYSIS ARE GIVEN AT JPL TO ASSIST COMPUTER USERS IN KEEPING ABBREAST OF SOUND NEW NUMERICAL TECHNIQUES. CONSULTATION IS ALSO PROVIDED ON SPECIFIC APPLICATIONS. THE MATHEMATICS OF DIFFERENTIAL GEOMETRY, AND OF INVOLUTORY SETS OF NON-LINEAR PARTIAL DIFFERENTIAL EQUATIONS, IS TO BE STUDIED FROM THE NOVEL STANDPOINT OF HIGH SPEED, NON-NUMERICS MACHINE MANIPULATION OF THE ALGEBRA OF EXTERIOR DIFFERENTIAL FORMS. AREAS IN WHICH FURTHER DEVELOPMENT OF MATHEMATICAL TECHNIQUES WILL BE UNDERTAKEN ARE: THEORY OF CONFORMAL MAPPING; THEORY OF REPRESENTATIONS OF GROUPS, INCLUDING LIE GROUPS, AND LIE AND ASSOCIATIVE ALGEBRAS; EVALUATION AND TABULATION OF INTEGRALS OF THE SPECIAL FUNCTIONS; THEORY OF HILBERT TRANSFORMS; THEORY OF THE NUMERICAL COMPUTATION OF THE SPECIAL FUNCTIONS; AND THEORY OF THE GENERAL GIBBS' PHENOMENON.

RTOP NO. 129-04-20 TITLE: MATHEMATICS  
ORGANIZATION: NASA/ELECTRONICS RESEARCH CTR.  
MONITOR: SCHUCK, H. O. TEL. 617-494-2355  
TECHNICAL SUMMARY

WORK IS BEING PERFORMED IN A BROAD AREA OF APPLIED MATHEMATICS RELATED TO FUNDAMENTAL ASPECTS OF ANALYSIS AND DESIGN INCLUDING STOCHASTIC PROCESSES, OPTIMIZATION, ALGEBRAIC SYSTEMS THEORY, DISTRIBUTED SYSTEMS AND STATISTICAL FILTERING. UNDERLYING AERONAUTICS AND SPACE VEHICLE CONTROL TECHNOLOGY ARE PHYSICAL/MATHEMATICAL MODELS WHICH REQUIRE EFFICIENT PROCEDURES FOR OPTIMIZATION OF SYSTEM PERFORMANCE AND DESIGN. PAPER AND PENCIL TECHNIQUES ARE BACKED UP BY SOPHISTICATED COMPUTER SIMULATIONS AND NUMERICAL PRECEDURES. RESULTS OF THE RESEARCH ARE REPORTED IN NASA PUBLICATIONS, TECHNICAL JOURNALS AND AT LEADING TECHNICAL CONFERENCES. THIS WORK IS BEING DONE TO PROVIDE GOOD MATHEMATICAL MODE AND ANALYTICAL TECHNIQUES FOR FUTURE AEROSPACE VEHICLES AND SYSTEMS SUCH AS V/STOL, SST, AIR TRAFFIC, LAUNCH VEHICLES, UNMANNED SPACECRAFT PROBES AND MANNED SPACE VEHICLES.

RTOP NO. 129-04-20 TITLE: MATHEMATICS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RTOP IS TO PURSUE RESEARCH IN BASIC APPLIED MATHEMATICS SUCH AS ANALYTICAL MECHANICS, DIFFERENTIAL EQUATIONS AND MANY APPLICATIONS TO PHYSICS. SPECIFICALLY, THIS WORK WILL BE CONCERNED WITH TECHNIQUES FOR SOLVING DIFFERENTIAL AND INTEGRAL EQUATIONS WITH EMPHASIS ON THE IDENTIFICATION OF CRITICAL

ITEMS AFFECTING ACCURACY AND EFFICIENCY. THIS WORK WILL FIND APPLICATION IN A WIDE RANGE OF PROBLEMS FOR WHICH DIGITAL COMPUTER SOLUTIONS WILL BE REQUIRED.-----

RTOP NO. 129-04-20 TITLE: MATHEMATICS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: GOODWIN, G. TEL. 205-453-1120  
TECHNICAL SUMMARY

THERE ARE TWO MAJOR OBJECTIVES: (A) DETERMINATION OF THE ADVANTAGES AND LIMITATIONS OF THE KALMAN FILTERING TECHNIQUE AND, (B) ADVANCED STATISTICAL MODELS WHICH WILL BE USED FOR MAKING PROBABILITY INFERENCES IN REGARD TO: (1) MISSION PLANNING AND OPERATIONS; (2) GRAVITATIONAL PARAMETERS, AND (3) MAGNETIC FIELD COMPONENTS. THE THEORY OF STOCHASTIC PROCESSES SHOULD BE INVESTIGATED TO ACCOMPLISH THE TASK. SPHERICAL HARMONIC MODELS SHOULD ALSO BE INVESTIGATED. OBJECTIVE (A) IS DIRECTLY RELATED TO POST FLIGHT TRACKING DATA PROCESSING AND REDUCTION. FOR OBJECTIVE (A) AN ANALYSIS WILL BE MADE OF THE ASSUMPTIONS REQUIRED BY THE VARIOUS KALMAN TYPE FORMULATIONS TO DETERMINE THE IMPORTANCE OF CONFORMING EXACTLY TO THE ASSUMPTION REQUIRED IN THE DEVELOPMENT. OBJECTIVE (B) IS REQUIRED BECAUSE ADVANCED MATHEMATICAL STATISTICAL MODELS ARE REQUIRED WHICH DEFINE CORRELATED VARIABLES WHICH MAY BE CRITICAL TO THE SUCCESS OF LAUNCH VEHICLE MISSIONS, TRAJECTORY ANALYSIS, AND SUBSEQUENT ORBIT. MODELS ARE ALSO REQUIRED TO REPRESENT THE EARTH'S GRAVITATIONAL AND MAGNETIC FIELDS.

RTOP NO. 129-04-20 TITLE: MATHEMATICS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: HALL, J. H. TEL.  
TECHNICAL SUMMARY

IT IS THE OBJECTIVE OF THIS WORK TO IMPROVE THE EFFICIENCY AND EFFECTIVENESS OF SOLVING ANALYTICAL PROBLEMS AND PROCESSING EXPERIMENTAL DATA BY USE OF IMPROVED TECHNIQUES IN APPLIED MATHEMATICS AND NUMERICAL ANALYSIS. COMPUTER OPERATING SYSTEMS (SOFTWARE) DEVELOPMENT WILL EMPHASIZE DIRECT MAN/MACHINE INTERACTION TO TAKE MAXIMUM ADVANTAGE OF AVAILABLE COMPUTER HARDWARE. THIS APPROACH TO SHORTENING THE COMMUNICATION LINK BETWEEN THE SCIENTIST AND THE PROBLEM SOLVING PROCESS IN LARGE COMPUTERS OFFERS SUBSTANTIAL GAINS IN PRODUCTIVITY OF THE SCIENTIST.

RTOP NO. 129-04-20 TITLE: MATHEMATICS  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: GESSOW, A. TEL. 202-962-3768  
TECHNICAL SUMMARY

THE GENERAL OBJECTIVE OF THIS PROGRAM IS TO ENCOURAGE THE DEVELOPMENT OF ANALYTICAL, STATISTICAL, AND NUMERICAL TECHNIQUES OF POTENTIAL VALUE TO NASA SCIENTISTS AND ENGINEERS. MATHEMATICAL RESEARCH AREAS TO BE EMPHASIZED ARE: ANALYSIS AND GEOMETRY;

PROBABILITY THEORY AND MATHEMATICAL STATISTICS; COMPUTATIONAL AND NUMERICAL ANALYSIS; MODERN CONTROL THEORY AND OPTIMIZATION TECHNIQUES; AND OPERATIONS RESEARCH AND SYSTEMS ANALYSIS. THE SCOPE OF THIS PROGRAM IS THUS VERY BROAD, WITH MOST OF THE DISCIPLINES COMMONLY ASSOCIATED WITH THE TERMS "PURE" AND "APPLIED" MATHEMATICS BEING INCLUDED. SPECIFIC OBJECTIVES OF THE HEADQUARTERS' MATHEMATICS PROGRAM ARE (I) TO COMPLEMENT THE MORE APPLIED RESEARCH BEING DONE AT THE NASA CENTERS WITH FUNDAMENTAL MATHEMATICAL RESEARCH TYPICALLY FOUND IN THE UNIVERSITY ENVIRONMENT AND (II) TO PROVIDE AN EFFECTIVE AVENUE FOR COMMUNICATION BETWEEN THE CENTER AND UNIVERSITY RESEARCHERS IN AREAS OF COMMON INTEREST. THOSE ASPECTS OF MATHEMATICAL RESEARCH WHICH ARE CLEARLY RELEVANT TO THE NEEDS OF OUR RESEARCHERS IN THE PHYSICAL, ENGINEERING ENVIRONMENTAL, AND LIFE SCIENCES WILL BE SPONSORED.

RTOP NO. 129-04-21 TITLE: INFORMATION SCIENCES  
ORGANIZATION: NASA HEADQUARTERS  
MONITOR: GESSOW, A. TEL. 202-962-3768  
TECHNICAL SUMMARY

THE OBJECTIVE OF RESEARCH IN THE INFORMATION SCIENCES IS TO ENCOURAGE ADVANCES IN THOSE DISCIPLINES RELATED TO THE TRANSMISSION, ANALYSIS, STORAGE AND RETRIEVAL OF INFORMATION AS WELL AS WITH THOSE DISCIPLINES DIRECTED TOWARD THE USE OF THIS INFORMATION IN THE PROCESSES OF PLANNING, DECISION MAKING AND CONTROL. SPECIFIC RESEARCH AREAS INCLUDE: THE THEORY OF AUTOMATA AND MACHINE ORGANIZATION; INFORMATION CLASSIFICATION AND RETRIEVAL; PROGRAMMING LANGUAGE AND LINGUISTICS RESEARCH; DECISION THEORY AND GAME THEORY; AND INTERACTIVE SYSTEMS AND INFORMATION DISPLAY. TWO POINTS MUST BE STRONGLY EMPHASIZED WITH RESPECT TO THIS PROGRAM. THE FIRST IS THAT RESEARCH IN THE INFORMATION SCIENCES IS NOT AN OUTGROWTH OR CONTINUATION OF WORK NOW CONDUCTED BY THE APPLIED MATHEMATICS BRANCH: IT IS A NEW PROGRAM. THE SECOND POINT IS THAT RESEARCH IN THIS AREA IS VITALLY IMPORTANT TO THE SUCCESSFUL COMPLETION OF FUTURE NASA MISSIONS. ALREADY WE ARE BEING SWAMPED WITH DATA FROM BOTH EARTH-BASED AND SPACE EXPERIMENTAL SYSTEMS, AND EXPERIMENTS PLANNED FOR THE NOT-SO-DISTANT FUTURE MAKE TODAY'S PROBLEMS SEEM TRIVIAL BY COMPARISON. FOR EXAMPLE, THE INFORMATION RATE FROM JUST ONE PROPOSED PROGRAM, THE EARTH RESOURCES SATELLITE, PROMISES TO YIELD THE EQUIVALENT OF OVER 10 6 AVERAGE SIZED BOOKS PER DAY. THUS RESEARCH IN THE INFORMATION SCIENCES HAS A UNIQUE ASPECT OF URGENCY AND POTENTIAL PRODUCTIVITY.

RTOP NO. 129-04-21 TITLE: INFORMATION SCIENCES  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: VAN METER, D. TEL. 617-494-2646  
TECHNICAL SUMMARY

OBJECTIVE IS TO DEVELOP AND EXTEND VARIOUS BRANCHES OF THEORY WHICH ARE NEEDED FOR ADVANCED INFORMATION RETRIEVAL AND ARTIFICIAL INTELLIGENCE SYSTEMS. ADVANCED STUDY, AND COMPUTER AND DEVICE IMPLEMENTATIONS, WILL BE PERFORMED IN-HOUSE AND UNDER CONTRACT, TO

DEVELOP THE RELEVANT THEORY AND TO INDICATE SUITABLE APPLICATION TO NASA PROBLEMS IN HANDLING AND ACTING UPON VERY LARGE MASSES OF INFORMATION.

RTOP NO. 129-04-22 TITLE: ASTRODYNAMICS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: VAN METER, D. TEL. 205-453-1120  
TECHNICAL SUMMARY

THE MAJOR OBJECTIVE OF THIS WORK IS THE LIFETIME PREDICTION OF SPENT STAGES IN HIGHLY ECCENTRIC ORBITS (ECCENTRICITY GREATER THAN 0.95). THIS WORK IS DIRECTLY APPLICABLE TO ORBITAL DEBRIS AND EARTH IMPACT AS WELL AS BEING APPLICABLE TO LUNAR MISSIONS IN WHICH LARGE SPENT STAGES ARE LEFT IN HIGHLY ECCENTRIC ORBITS. AN ANALYSIS WILL BE MADE TO DETERMINE THE PERTURBING EFFECT OF THE SUN AND MOON ON HIGHLY ECCENTRIC EARTH ORBITS.

RTOP NO. 129-04-22 TITLE: ASTRODYNAMICS  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: VAN METER, D. TEL. 617-494-2646  
TECHNICAL SUMMARY

OBJECTIVE IS TO IMPROVE UPON AND DEVELOP NEW MATHEMATICAL TECHNIQUES FOR ANALYSIS OF PROBLEMS IN CELESTIAL MECHANICS, TRAJECTORY OPTIMIZATION, AND MODERN CONTROL THEORY ENCOUNTERED IN MISSION PLANNING AND ANALYSIS AND IN THE ON-BOARD COMPUTATIONAL ASPECTS OF GUIDANCE, NAVIGATION AND CONTROL. THIS INCLUDES SEARCH FOR MULTIVARIATE FUNCTION APPROXIMATION TECHNIQUES, INTEGRALS OF THE MOTION AND SOLUTIONS TO THE SPLIT-BOUNDARY VALUE PROBLEM IN ORBITAL MECHANICS, AND DEVELOPMENT OF THEORY IN CALCULUS OF VARIATIONS FROM BOTH CLASSICAL AND MODERN FUNCTIONAL ANALYSIS VIEWPOINTS.

RTOP NO. 129-04-22 TITLE: ASTRODYNAMICS  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: HEINDL, C. J. TEL. 213-354-3279  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS TASK ARE TO: CONDUCT BASIC RESEARCH IN ADVANCED TECHNIQUES FOR THE GENERATION OF ANALYTIC, LITERAL AND NUMERICAL SOLUTIONS OF SYSTEMS OF NONLINEAR DIFFERENTIAL EQUATIONS OF BOTH THE INITIAL VALUE AND BOUNDARY-VALUE TYPE SUCH AS ARISE IN BALLISTIC AND GUIDED FLIGHT MECHANICS; DEVELOP OPTIMUM PERTURBATION TECHNIQUES FOR ANALYTIC APPROXIMATION OF SUCH SYSTEMS; DEVELOP PRACTICAL OPTIMUM TECHNIQUES FOR THE EVALUATION OF TRAJECTORY AND OTHER PARAMETERS OF SUCH SYSTEMS IN THE PRESENCE OF NOISE-CONTAMINATED OBSERVATIONS; CONDUCT BASIC INVESTIGATIONS ON THE USE OF EARTH-BASED RADAR SYSTEMS TO DETECT GENERAL RELATIVISTIC EFFECTS IN DATA OBTAINED FROM TRACKING A SPACECRAFT, INCLUDING THE INTERPRETATION OF THESE EFFECTS IN TERMS OF DIFFERENT RELATIVISTIC MODELS. THE OBJECTIVES OF THIS TASK HAVE BEEN MODIFIED TO THE EXTENT OF DELETING THE EVALUATION OF ASTRONOMICAL AND PHYSICAL CONSTANTS AND



THE IMPROVEMENT OF LUNAR AND PLANETARY EPHEMERIDES. THEY HAVE BEEN EXPANDED TO INCLUDE THE STUDY OF ADVANCED TECHNIQUES FOR THE TREATMENT OF SYSTEMS OF DIFFERENTIAL EQUATIONS, DETERMINISTIC OR STOCHASTIC, WHICH OCCUR IN ALMOST EVERY BRANCH OF APPLIED MATHEMATICS, BUT WITH PARTICULAR EMPHASIS ON THOSE PROBLEM AREAS WHICH ARE PECULIAR AND UNIQUE TO JPL IN THE PERFORMANCE OF ITS MISSION OBJECTIVES.

RTOP NO. 130-06-07 TITLE: MISSION ANALYSIS AND SYSTEM DEFINITION  
ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: BROOKS, G. W. TEL. 703-827-3585

TECHNICAL SUMMARY

STUDIES WILL BE ORIENTED TOWARD ANALYZING AND DEFINING PAYLOAD DELIVERY METHODS FOR EARTH, LUNAR, AND PLANETARY MISSIONS. IT WILL BE THE OBJECTIVE OF THESE STUDIES TO DEFINE THE MISSION MODE AND SYSTEMS REQUIREMENTS TO MOST EFFECTIVELY DELIVER PAYLOADS FOR A RANGE OF POTENTIAL MISSIONS. PLANETARY ATMOSPHERIC ENTRY MODES WILL BE STUDIED ALONG WITH TECHNIQUES FOR DECELERATING PAYLOADS IN THE ATMOSPHERE AND LANDING ON THE PLANET'S SURFACE. STUDIES WILL BE CONDUCTED TO ASSURE THE COMPATIBILITY OF DELIVERY MODES WITH MISSION REQUIREMENTS. REQUIRED SYSTEMS WILL BE SYNTHESIZED. DETAILED PLANETARY TARGETING ANALYSIS WILL BE DONE ON CONTRACT. THE PRIMARY OBJECTIVE WILL BE TO MATE ENGINEERING HARDWARE DEVELOPMENT WITH FUTURE MISSION REQUIREMENTS SO THAT LONG LEAD TECHNOLOGY ITEMS CAN BE INITIATED IN A TIMELY MANNER. TECHNOLOGY APPLICATIONS AND ADVANCED CONCEPTS WILL BE EXPLORED FOR A VENUS BUOYANT STATION, FOR LOGISTIC VEHICLES TO SUPPORT A SPACE STATION, AND FOR OTHER MAJOR FUTURE PLANETARY MISSIONS. STUDIES WILL BE PRIMARILY IN-HOUSE SUPPLEMENTED BY CONTRACTS IN SPECIALIZED AREAS AS REQUIRED.

RTOP NO. 130-06-08 TITLE: SPACE PROGRAM PLANNING ANALYSIS

ORGANIZATION: AMES

MONITOR: DEERWESTER, J. M. TEL. 415-961-1111

TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO ANALYZE, DEVELOP AND TEST LONG-RANGE PLANNING METHODOLOGIES. THE METHODOLOGIES WILL PROVIDE FOR: THE CONSIDERATION OF ALTERNATIVE GOALS AND ALTERNATIVE PROGRAMMATIC COURSES OF ACTION; ASSESSMENT OF THE RISKS AND UNCERTAINTIES ASSOCIATED WITH THE OUTCOMES AND SUCH COURSES OF ACTION AND AN EVALUATION OF THE CONTRIBUTIONS THAT THE OUTCOMES MAY YIELD IN APPROACHING THE GOALS; ASSESSMENT OF THE ECONOMIC AND RESOURCE IMPLICATIONS OF PROGRAM ALTERNATIVES; DESCRIPTIONS OF THE ASSOCIATED TECHNICAL REQUIREMENTS AND CAPABILITIES; AND THE EXERCISE OF VARIOUS DECISION-MAKING PROCESSES ASSUMED FOR THE PURPOSE OF ANALYSIS.

**RTOP NO. 130-06-09    TITLE: TECHNICAL REQUIREMENTS AND CAPABILITIES ANALYSIS**

**ORGANIZATION: AMES**

**MONITOR:        SWAN, P. R.**

**TEL. 415-961-1111**

**TECHNICAL SUMMARY**

ELEMENTS OF ATTRACTIVE POSSIBLE FUTURE MISSIONS AND SPACECRAFT AND LAUNCH VEHICLE SYSTEMS ARE ANALYZED WITH A VIEW TOWARD DEFINING SYSTEMS REQUIREMENTS. THESE SYSTEMS REQUIREMENTS SERVE TO AID IN SELECTING DIRECTIONS FOR OART TECHNOLOGY DEVELOPMENT ACTIVITIES. THIS WORK IS CONDUCTED IN CONCERT WITH OVERALL STUDIES OF ADVANCED MISSIONS UNDER THE ADVANCED STUDY (CODE 789) PROGRAM. TYPICAL SUBJECTS STUDIED INCLUDE SPACE TRAJECTORIES, SPACE MISSION OPERATIONS, ELECTRIC PROPULSION SYSTEMS, SENSOR SYSTEM REQUIREMENTS, ETC.

**RTOP NO. 130-06-10    TITLE: AERONAUTICAL PROGRAM ANALYSIS**

**ORGANIZATION: AMES**

**MONITOR:        DRAKE, H. M.**

**TEL. 415-961-1111**

**TECHNICAL SUMMARY**

THE OBJECTIVE OF THIS WORK IS TO CONDUCT TRANSPORTATION STUDIES, WITH EMPHASIS ON AIRCRAFT AND AIRCRAFT-RELATED SYSTEMS, IN ORDER TO PROVIDE INFORMATION RELEVANT TO: (A) THE PLANNING OF FUTURE AERONAUTICAL TRANSPORTATION SYSTEMS (B) THE PLANNING OF FUTURE AERONAUTICAL RESEARCH AND DEVELOPMENT PROGRAMS. THESE STUDIES WILL INVOLVE THE DEVELOPMENT AND APPLICATION OF ANALYTICAL TECHNIQUES TO INVESTIGATE THE IMPACTS OF CHANGES IN DEMAND, ALTERNATE TRANSPORTATION MODES, TECHNOLOGY ADVANCES, CHANGES IN OPERATING PROCEDURES, ETC. ON THE EVOLUTION OF TRANSPORTATION SYSTEMS; AND TO ESTIMATE THE COSTS AND BENEFITS OF ALTERNATIVE AERONAUTICAL RESEARCH AND DEVELOPMENT PROGRAMS.

**RTOP NO. 130-06-11    TITLE:**

**ORGANIZATION: AMES RES. CENTER**

**MONITOR:        HORNBY, H.**

**TEL. 415-961-1111**

**TECHNICAL SUMMARY**

ECONOMIC AS WELL AS TECHNOLOGICAL PROBLEMS ARE KEY FACTORS IN DETERMINING THE FUTURE DIRECTION OF THE SPACE PROGRAM. EFFECTIVE, VIABLE PROGRAM ANALYSES THEREFORE MUST INCLUDE ECONOMIC MEASURES AND FORECASTS. ANALYSES WOULD INVESTIGATE PROGRAM ECONOMICS IN TERMS OF COSTS AND BENEFITS, USING APPROPRIATE ESTIMATION TECHNIQUES AND MODELS SUCH AS AN EXISTING SELECTION ALGORITHM. SENSITIVITIES TO VARIATIONS IN TECHNOLOGY AND RESOURCE AVAILABILITY, BUDGET LIMITATIONS AND CONSTRAINTS, AND MANAGEMENT AND OPERATIONAL PHILOSOPHY WOULD BE INCLUDED. A BUDGET SMOOTHING MODEL IS CURRENTLY PROVIDING SIGNIFICANT SENSITIVITY DATA. AN EXTENSIVE DATA BANK IS ALSO CURRENTLY IN USE. THE RESULTS THEN ARE AN ASSESSMENT OF THE IMPACT OF ECONOMIC CONSIDERATIONS UPON PROGRAM ANALYSIS AND TECHNOLOGY PLANNING.

RTOP NO. 130-06-14 TITLE: STUDY OF FUTURE PLANETARY MISSIONS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: BROOKS, G. W. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO PROVIDE STUDIES OF FUTURE SPACE MISSIONS TO ASSIST IN DEVELOPING THE BASIS FROM WHICH DECISIONS CAN BE MADE ON THE FUTURE SPACE MISSIONS AND MISSION MODES. THESE STUDIES INCLUDE PRELIMINARY STUDIES OF FUTURE SPACE MISSIONS AND TECHNIQUES; FEASIBILITY STUDIES OF MISSIONS PROPOSED AS A RESULT OF PRELIMINARY STUDIES; AND, IN SOME CASES, PRELIMINARY SYSTEMS ANALYSES FOR ATTRACTIVE MISSIONS. THE NEEDS FOR VARIOUS MISSIONS, INCLUDING THE TYPES OF ORBITS, TYPES OF PROPULSION SYSTEMS, TYPES OF SPACECRAFT, MEASUREMENTS AND INSTRUMENTATION, AND MODES OF OPERATION ARE BEING STUDIED. AN INTEGRAL PART OF THIS EFFORT IS THE DEFINITION OF THE REQUIREMENTS FOR PLANETARY LANDINGS AT PRESELECTED SITES. THESE ARE BEING STUDIED IN TERMS OF OPTIMUM SITE LOCATION, SPACECRAFT LIFT-DRAG RATIO AND LATERAL RANGE REQUIREMENTS. BOTH TARGET PLANET SITES AND EARTH RETURN RECOVERY NETWORKS ARE BEING STUDIED. EXTENSIVE USE OF ANALYTICAL METHODS AS WELL AS THE DEVELOPMENT AND USE OF COMPUTER PROGRAMS FOR LAUNCH, FREE SPACE, AND ENTRY TRAJECTORY ANALYSES ARE REQUIRED TO ACHIEVE THE OBJECTIVES OF THIS PROGRAM.

RTOP NO. 130-06-17 TITLE: AUXILIARY PROPULSION SYSTEMS TECHNOLOGY  
FOR UNMANNED SPACECRAFT  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: ISLEY, W. C. TEL. 301-982-6389  
TECHNICAL SUMMARY

FUTURE REQUIREMENTS FOR AUXILIARY PROPULSION OF UNMANNED SPACECRAFT WILL BE CONTINUALLY ANALYZED USING AVAILABLE PLANNING TOOLS SUCH AS FUTURE MISSION MODELS, "OBJECTIVES AND GOALS IN SPACE SCIENCE AND APPLICATIONS" (NASR SP-162), OSSA PROSPECTUS, AND OTHER SOURCES OF PROSPECTIVE MISSION REQUIREMENTS. THESE ANALYSES WILL BE FORMALIZED AND UTILIZED TO DETERMINE APPROPRIATE CANDIDATE THRUSTER SYSTEMS AND PROPER PROGRAM TIMING. THE PROPOSED THRUSTER SYSTEMS INCLUDING THE EFFECTS ON SPACECRAFT, WILL BE COMPARATIVELY EVALUATED BOTH ANALYTICALLY AND EXPERIMENTALLY VIA GROUND TESTING IN THE GSFC ELECTRIC PROPULSION SIMULATOR. IN ADDITION, SPACE TESTS SUCH AS THOSE OF THE RESISTOJET AND ION ENGINE ON ATS WILL BE CONDUCTED AS REQUIRED TO ASSESS SYSTEM PERFORMANCE RELATING TO THE PROPULSION FUNCTIONS IDENTIFIED IN THE ANALYSES. ALTHOUGH THE PRINCIPAL THRUSTER TECHNOLOGY MAY BE DERIVED FROM RESEARCH EFFORTS CONDUCTED ELSEWHERE, E.G., LEWIS RESEARCH CENTER, USAF, OR JET PROPULSION LABORATORY, IT IS ANTICIPATED THAT CRITICAL SYSTEMS TECHNOLOGY WILL NOT BE AVAILABLE FROM SUCH EFFORTS. SUCH SYSTEMS DEVELOPMENT WILL BE CLOSELY TIED TO SPECIFIC MISSION MODELS AND WILL INCLUDE INTERFACE CONSTRAINTS AS WELL AS BASIC PERFORMANCE REQUIREMENTS. THIS WILL INVOLVE RELATED RESEARCH AS REQUIRED ON SELECTED SYSTEMS.

RTOP NO. 131-05-01 TITLE: AEROSPACE SAFETY DATA BANK  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: GOLDSTEIN, C. M. TEL. 216-433-4000  
TECHNICAL SUMMARY

OBJECTIVE: TO ESTABLISH AN AEROSPACE SAFETY DATA BANK TO GATHER, ANALYZE AND DISSEMINATE TECHNICAL SAFETY-RELATED INFORMATION AVAILABLE TO ALL ELEMENTS OF NASA, ITS CONTRACTORS AND THE TECHNICAL COMMUNITY; TO ASSURE THAT INFORMATION ON THE LATEST STATE-OF-THE-ART REGARDING SAFETY IS AVAILABLE FOR USE IN PLANNING, DESIGN, FABRICATION, TESTING AND OPERATIONS OF AEROSPACE VEHICLES AND SYSTEMS AND ASSOCIATED FACILITIES. APPROACH: THE ASRDI WILL CALL ON ALL ELEMENTS OF NASA, ITS CONTRACTORS, AND OTHER ORGANIZATIONS TO PROVIDE BASIC, APPLIED AND OPERATIONAL DATA RELATED TO GROUND-BASED AND FLIGHT SAFETY EXPERIENCE FOR THE AEROSPACE SAFETY DATA BANK. INVESTIGATION WILL BE MADE OF SIMILAR ACTIVITIES IN GOVERNMENT AND INDUSTRY TO ESTABLISH THE EXTENT AND NATURE OF EXISTING COMPILATIONS OF ACCURATE DATA. LIAISON WILL BE ESTABLISHED WITH THESE ACTIVITIES TO ASSURE ACCESS TO THE INFORMATION CONTAINED IN THESE SOURCES AS NEEDED, AND/OR SELECTED INFORMATION WILL BE IDENTIFIED AND INCORPORATED INTO THE ASRDI AEROSPACE SAFETY DATA BANK AS APPROPRIATE. A MANAGEMENT MECHANISM WILL BE ESTABLISHED TO PROVIDE FOR THE FLOW OF ALL SUCH INFORMATION INTO THE DATA BANK. THE INFORMATION WILL BE ANALYZED, VERIFIED, CORRELATED AND QUALIFIED AS REQUIRED. THIS INFORMATION WILL BE MADE AVAILABLE TO ALL ELEMENTS OF NASA, ITS CONTRACTORS, OTHER GOVERNMENT AGENCIES, AND THE TECHNICAL COMMUNITY. IMPROVED METHODS OF STORING, SEARCHING AND RETRIEVING INFORMATION WILL HAVE A WIDESPREAD APPLICABILITY IN THE GENERAL AREA OF INFORMATION PROCESSING.

RTOP NO. 131-05-02 TITLE: AERONAUTICAL SAFETY RESEARCH  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: WEISS, S. TEL. 216-433-4000  
TECHNICAL SUMMARY

ASRDI WILL MAINTAIN AN OVERVIEW OF AERONAUTICAL SAFETY RESEARCH PROGRAMS. IT WILL COMPARE CURRENT PROGRAMS WITH AIRCRAFT SAFETY INFORMATION REQUIREMENTS TO ESTABLISH THE NEED FOR ADDITIONAL RESEARCH. IN ASSOCIATION WITH THE AERONAUTICS DIVISION OF OART, NASA CENTERS AND THE AIRCRAFT COMMUNITY, CONDUCT RESEARCH PROGRAMS AS REQUIRED TO SEEK PRACTICAL SOLUTIONS TO SAFETY PROBLEMS ASSOCIATED WITH AIRCRAFT AND THEIR GROUND BASED ACTIVITIES. THESE RESEARCH PROGRAMS WILL BE DESIGNED TO PROVIDE NEW TECHNIQUES FOR HANDLING PRESENT SAFETY PROBLEMS AND THOSE ANTICIPATED BY THE INTRODUCTION OF NEW AIRCRAFT TYPES, NOVEL AIRCRAFT COMPONENTS AND UNCONVENTIONAL STRUCTURAL MATERIALS. FLIGHT MODES PROJECTED FOR FUTURE AIRPLANES, WHICH ADD TO THE PILOT WORKLOAD, RAISE MAN-MACHINE PROBLEMS WHICH WILL REQUIRE INCREASED ATTENTION.

RTOP NO. 131-05-03 TITLE: SPACE SAFETY RESEARCH  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: HACKER, P. T. TEL. 216-433-4000  
TECHNICAL SUMMARY

IN ORDER TO MEET THE HIGH SAFETY STANDARDS THAT NASA WISHES TO ESTABLISH IN ITS SPACE ACTIVITIES BOTH IN FLIGHT AND IN TEST FACILITIES, ASRDI WILL PERFORM THE FOLLOWING FUNCTIONS IN SUPPORT OF THE TOTAL NASA SAFETY EFFORT IN ASSOCIATION WITH OTHER NASA GROUPS:

1. DEFINE THE REQUIREMENTS OF SPACE VEHICLE AND FACILITY SYSTEMS THAT MINIMIZE RISK, SINCE SPACE VEHICLES REPRESENT COMPACT COMBINATIONS OF VITAL SYSTEMS IN WHICH A FAILURE IN ONE HAS A HIGH LIKELIHOOD OF DAMAGING THE OTHER. THE NEED FOR LOW SYSTEM FAILURE PROBABILITY AND HIGH RECOVERY RATE, SHOULD FAILURE OCCUR, IS MORE STRINGENT THAN PRESENT ENGINEERING EXPERIENCE OFTEN PROVIDES. TO IMPROVE THIS SITUATION, ASRDI WILL CONDUCT, OR HAVE CONDUCTED FOR IT, ENGINEERING EVALUATION OF EXISTING SAFETY RELATED INFORMATION, DRAWN FROM THE LITERATURE AND CURRENT PROGRAMS, WHICH FOCUS ON SPACE VEHICLE SAFETY TECHNOLOGY. GAPS IN INFORMATION WILL BE FILLED BY RESEARCH PROGRAMS CONDUCTED IN ASSOCIATION WITH OTHER SEGMENTS OF NASA. EVERY EFFORT WILL BE MADE TO PROVIDE THE INFORMATION EARLY ENOUGH FOR INCORPORATION IN THE EARLY PLANNING PHASES OF SPACE VEHICLE DESIGN AND OPERATION.
2. IMPROVE THE SAFETY OF SUPPORT FUNCTIONS IN NASA AND CONTRACTOR OPERATIONS WHICH RAISE INDUSTRIAL AND PUBLIC SAFETY PROBLEMS. RESEARCH IS OFTEN REQUIRED TO PROVIDE A BASIS FOR IMPROVED SAFETY CODES, PRACTICES AND AUXILIARY SAFETY EQUIPMENT. ASRDI WILL CONTRIBUTE RESEARCH AND OTHER TECHNICAL SUPPORT TO IMPROVE THE RULES AND TECHNIQUES BY WHICH SAFETY IS ACHIEVED IN THE AEROSPACE INDUSTRY. BECAUSE ASRDI RESEARCH IS OFTEN AIMED AT FILLING INFORMATION VOIDS IN A WIDE RANGE OF SAFETY FIELDS, THE CONNECTING THEME FOR ALL OF ASRDI RESEARCH CAN ONLY BE ITS RELEVANCE TO SAFETY.

RTOP NO. 320-01-01 TITLE: SPACE TECHNOLOGY APPLICATIONS  
ORGANIZATION: ELECTRONICS RESEARCH CENTER  
MONITOR: TRENT, R. L. TEL. 617-494-2449  
TECHNICAL SUMMARY

ERC WILL APPLY AEROSPACE TECHNOLOGY TO RESOLVE SPECIFIC PROBLEMS AFFECTING MODERN SOCIETY IN THE PUBLIC AND PRIVATE SECTORS, INVOLVING CRIMINAL JUSTICE, BIOMEDICAL AND COMMUNICATION ENGINEERING, DETECTION OF POLLUTANT LEVELS, AND OTHERS. A FIELD OF CANDIDATE PROBLEMS AND THEIR CORRESPONDING TECHNOLOGICAL SOLUTIONS WILL BE FORMULATED AND EVALUATED, IN COOPERATION WITH NASA HEADQUARTERS. INDIVIDUAL PROBLEMS WILL BE REVIEWED IN TERMS OF THE FOLLOWING: A) IDENTIFY AND ANALYZE PROBLEM REQUIREMENTS B) APPLICATION OF THE SYSTEMS APPROACH TO ARRIVE AT PROPOSED SOLUTIONS. C) SELECTION OF A MIX OF TASKS APPROPRIATE TO ERC'S IN-HOUSE CAPABILITY. D) USE OF SUBCONTRACTORS AS APPROPRIATE TO SUPPLEMENT SUCH IN-HOUSE CAPABILITIES. E) EMPHASIS ON QUICK RESPONSE TO URGENT REQUESTS FOR ASSISTANCE.

RTOP NO. 320-01-02 TITLE: SPACE TECHNOLOGY APPLICATIONS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

(1) DEVICES AND SENSORS DEVELOPED FOR LIFE SCIENCES RESEARCH AND OTHER NASA PURPOSES WILL BE ADAPTED TO APPLICATIONS REQUIRED BY THE MILITARY AND OTHER AGENCIES. (2) EXPERIMENTAL PROCEDURES TO DETERMINE THE PHYSICAL AND CHEMICAL PROPERTIES OF PSYCHOTOMMETIC COMPOUNDS ARE BEING DEVELOPED IN ORDER TO PERFECT ANALYTICAL METHODS WHICH PERMIT RAPID IDENTIFICATION OF COMPOUNDS WITH KNOWN BIOLOGICAL ACTIVITY, AND THE EVALUATION OF AS YET UNKNOWN MATERIALS WHICH MAY BE POTENTIALLY DANGEROUS (BIOLOGICALLY). THE MORE PROMISING ANALYTICAL TECHNIQUES WILL BE COUPLED FOR THE DEVELOPMENT OF SYSTEMS WHICH CAN BE USED FOR DETECTION AND IDENTIFICATION OF PSYCHOTOMMETIC COMPOUNDS BY MILITARY, LAW ENFORCEMENT, AND OTHER CIVIL AGENCIES. (3) ISOCYANURATE COMPOSITE FIRE-RETARDANT FOAMS ARE BEING DEVELOPED AS SECOND GENERATION FOAMS TO THE ALREADY ESTABLISHED POLYURETHANE FOAMS (5I CLASS, LOW DENSITY FOAMS). THIS FOAM WOULD BE APPLIED TO MILITARY AIRCRAFT AND WEAPONS AS WELL AS CIVIL AIRCRAFT AND STRUCTURES WHERE FIRE HAZARDS EXIST. (4) EXPERIMENTAL INTUMESCENT COATINGS WILL BE FORMULATED AND THEIR THERMAL PROTECTION VALUE WILL BE DETERMINED. THE IMMEDIATE USE FOR THESE COATINGS WOULD BE TO PROTECT MILITARY EQUIPMENT AND ORDNANCE AS WELL AS COMMERCIAL AIRCRAFT AND STRUCTURES IN A FUEL FIRE ENVIRONMENT.

RTOP NO. 320-01-05 TITLE: SPACE TECHNOLOGY APPLICATIONS  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: SPENCER, D. F. TEL. 213-354-2564  
TECHNICAL SUMMARY

JPL WILL APPLY SPACE-DERIVED CAPABILITIES TO THE RESOLUTION OF DOD PROBLEMS AND OTHERS OF NATIONAL INTEREST, PARTICULARLY THOSE RELATING TO THE CIVIL SYSTEMS ARE AS INCLUDING CRIMINAL JUSTICE, MEDICAL ENGINEERING, AND OTHERS. SPACE-DERIVED CAPABILITIES INCLUDE EXPERIENCE AND TECHNOLOGY THAT IS APPLICABLE IN: 1) PROJECT AND SYSTEMS MANAGEMENT. 2) SYSTEMS ANALYSIS AND PROJECT ENGINEERING. 3) SPECIALIZED TECHNICAL DISCIPLINES (E.G., COMMUNICATIONS, GUIDANCE, PROPULSION, ETC.) 4) DESIGN, OPERATION AND EVALUATION OF COMPLEX TEST PROGRAMS. FROM THE CIVIL SYSTEMS AREAS JPL WILL (1) IDENTIFY AND ANALYZE PROBLEMS, (2) DETERMINE REQUIREMENTS, (3) APPLY A SYSTEMS APPROACH, (4) SELECT A MIX OF TASKS APPROPRIATE TO CAPABILITY, (5) USE SUBCONTRACTORS AS APPROPRIATE, (6) EMPHASIZE A QUICK RESPONSE TO URGENT REQUESTS.

RTOP NO. 320-01-07 TITLE: LONG RANGE LASER TRAVERSING SYSTEM  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: CAUDILL, L. O. TEL. 301-982-4969  
TECHNICAL SUMMARY

THIS RTOP IS FOR DEVELOPMENT OF A LIGHTWEIGHT, BACKPACKED PROTOTYPE LASER SYSTEM AND FOR PERFORMING FIELD EVALUATION EXPERIMENTS TO DETERMINE THE FEASIBILITY OF ESTABLISHING PRECISE LINE



OF SIGHT USING THE SCATTERED LASER LIGHT FROM A DISTANCE VERTICALLY POINTED LASER. THIS WORK IS A DIRECT APPLICATION OF OPTICAL TECHNOLOGY DEVELOPED UNDER OART PROGRAM AND WILL PROVIDE THE U. S. FOREST SERVICE WITH A SURVEYING TECHNIQUE THAT WILL SAVE A GREAT DEAL OF TIME AND MONEY.

RTOP NO. 703-01-01 TITLE: RADIO TELESCOPE STRUCTURAL TECHNOLOGY  
FLIGHT EXPERIMENTS

ORGANIZATION: GSFC

MONITOR: HIBBARD, W. D. TEL. 301-982-4278

TECHNICAL SUMMARY

OBJECTIVE: PERFORM FLIGHT EXPERIMENTS ON SCALED MODEL RADIO TELESCOPE STRUCTURES TO DEVELOP AND DEMONSTRATE TECHNICAL FEASIBILITY AND TECHNOLOGY READINESS FOR FULL SCALE SYSTEMS. APPROACH: THIS RTOP COVERS WORK PROPOSED AS A NEW START FOR FY 71. IT IS RELATED TO RTOP 124-08-19-51 INASMUCH AS IT PROVIDES FOR IMPLEMENTATION OF THE FLIGHT TEST PROGRAM REQUESTED THEREIN. IMPLEMENTATION OF THE PLAN WILL INCLUDE DETAIL DEFINITION, EXPERIMENT HARDWARE DEVELOPMENT AND FLIGHT TEST OF A PARABOLOID ANTENNA STRUCTURE, INCLUDING ASSOCIATED SUBSYSTEMS SUCH AS ATTITUDE CONTROL, INSTRUMENTATION, RADIO FREQUENCY RECEIVERS AND OTHERS. A BALLISTIC FLIGHT IS PLANNED WITH THE POSSIBILITY OF AN ORBITAL FLIGHT FOLLOWING.

RTOP NO. 704-13-01 TITLE: SERT II

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: RULIS, R. J. TEL. 206-433-4000

TECHNICAL SUMMARY

THE OBJECTIVES OF THE SERT II PROGRAM ARE TO DEMONSTRATE THE ENDURANCE CAPABILITY, RELIABILITY, AND COMPATIBILITY OF AN INTEGRATED ION THRUSTOR SYSTEM CAPABLE OF PERFORMING SPACE MISSIONS. AN ELECTRIC PROPULSION SYSTEM CONSISTING OF A THRUSTOR, POWER SUPPLY, POWER CONDITIONING AND RELATED EXPERIMENTS WILL BE SUBJECTED TO A FLIGHT PROGRAM OF SIX MONTHS DURATION.

RTOP NO. 708-12-01 TITLE: BIOMEDICAL FLIGHT EXPERIMENTS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: KLEIN, H. P. TEL. 415-961-1111

TECHNICAL SUMMARY

A NUMBER OF BIOMEDICAL FLIGHT EXPERIMENTS SUITABLE FOR USE IN

THE 1975 SPACE STATION ARE BEING PREPARED. THESE FLIGHT EXPERIMENTS WILL PROVIDE KNOWLEDGE ABOUT THE EFFECTS OF WEIGHTLESSNESS ON THE BEHAVIORAL AND BIOMEDICAL PERFORMANCE OF ANIMALS AND MAN, ABOUT ADAPTATION TO A CHANGED ENVIRONMENT AND THE MECHANISMS UNDERLYING SUCH ADAPTATIONS, AND ON WHICH TO PREDICT MAN'S PERFORMANCE DURING LONG TIME DURATION SPACE FLIGHTS. EXPERIMENTS BEING PREPARED THAT INVOLVE MAN AS THE SUBJECT ARE (1) DISTRIBUTION OF BODY FLUIDS, (2) OPERATOR TRANSFER FUNCTION, (3) VISUAL FUNCTION, AND (4) CARDIOPULMONARY FUNCTION. EXPERIMENTS UNDER PREPARATION REQUIRING THE USE OF ANIMALS ARE (1) BASAL METABOLISM OF MAMMALS UNDER VARYING GRAVITATIONAL FIELDS, (2) REGENERATION OF TISSUE (E.G., LIVER UNDER VARYING GRAVITY FIELDS), (3) HEALING AND RECOVERY FROM WOUNDS AND FRACTURES IN WEIGHTLESSNESS, (4) BONE MARROW ACTIVITY, (5) CALCIUM METABOLISM, AND (6) ADAPTATION AND FUNCTION OF THE CARDIOVASCULAR SYSTEM.

RTOP NO. 708-13-01 TITLE: BIOINSTRUMENTATION FLIGHT EXPERIMENTS  
ORGANIZATION: ELECTRONICS RESEARCH CENTER

MONITOR: LEAVITT, W. Z. TEL. 617-494-2417

TECHNICAL SUMMARY

FLIGHT INSTRUMENTS WILL BE DESIGNED AND DEVELOPED TO SUPPORT THE NEEDS OF DEVELOPING SPACE FLIGHT SYSTEMS FOR ENVIRONMENTAL CONTROL AND LIFE SUPPORT. THE INSTRUMENTS WILL BE USED TO ASSESS AND MONITOR THE GASEOUS, PARTICULATE, AND MICROBIAL CONTAMINATION OF THE ATMOSPHERE, WATER, FOOD, WASTE, AND HUMAN SYSTEMS. THE AEROSOL PARTICLE ANALYZER ORIGINALLY DESIGNED FOR FLIGHT AS-204 IS BEING REFURBISHED FOR THE AAP-2 FLIGHT. DOCUMENTATION FOR THE EXPERIMENT AND PROCUREMENT SPECIFICATIONS FOR THE INSTRUMENT ARE BEING COMPLETED.

RTOP NO. 708-15-01 TITLE: HUMAN FACTORS FLIGHT EXPERIMENTS  
ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: NELSON, C. H. TEL. 703-827-3285

TECHNICAL SUMMARY

EXPERIMENT DEFINITION HAS BEEN COMPLETED AND SPACECRAFT CONCEPTS HAVE BEEN DEFINED FOR OBTAINING PHYSIOLOGICAL AND PERFORMANCE DATA ON A HIGHER ORDER MAMMALIAN SYSTEM IN ZERO GRAVITY ENVIRONMENT FOR PERIODS UP TO ONE YEAR. CERTAIN SPACECRAFT SUBSYSTEMS, SUCH AS WASTE MANAGEMENT, FEEDER AND PRIMATE MASS MEASUREMENT, WILL REQUIRE EXPERIMENTAL VERIFICATION TO DEMONSTRATE THE TECHNICAL FEASIBILITY OF DESIGN APPROACHES. A CONCEPT OF AN ONBOARD CENTRIFUGE FOR FUTURE MANNED SPACECRAFT IS BEING DEVELOPED FOR THE SPACE RESEARCH ON MAN'S PHYSIOLOGICAL RESPONSE TO WEIGHTLESSNESS AND TO ARTIFICIAL GRAVITY AND ON HIS PERFORMANCE CAPABILITIES IN A ROTATING ENVIRONMENT. AN IMMEDIATE REQUIREMENT EXISTS WITHIN THIS PROGRAM FOR THE DETAILED DEFINITION OF THE REQUIREMENTS FOR THE PHYSIOLOGICAL AND PERFORMANCE INFORMATION AND THE ADVANTAGES AND/OR DISADVANTAGES OF OBTAINING THIS INFORMATION BY USE OF A CENTRIFUGE VERSUS A ROTATING SPACE STATION. THIS REQUIREMENT WILL BE FULFILLED BY AN IN-HOUSE STUDY. SIMULTANEOUSLY, A CONTRACTUAL EFFORT CONSISTING OF A TRADEOFF ANALYSIS OF OPTIONS FOR

OBTAINING THE NECESSARY INFORMATION VERSUS TOTAL PROGRAM COSTS WILL BE PERFORMED.

RTOP NO. 709-13-01 TITLE: RADIATION AND METEOROID SATELLITE  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: RICHMOND, R. G. TEL. 713-483-3816  
TECHNICAL SUMMARY

THE RADIATION AND METEOROID SATELLITE PROGRAM IS BEING CARRIED OUT UNDER CONTRACT NO. NAS 9-9195 WITH LONG-TEMCO-VOUGHT, INC. A PRELIMINARY DESIGN PHASE OF THE PROGRAM WAS COMPLETED IN NOVEMBER 1968 UNDER CONTRACT NO. NAS 9-8841. THIS STUDY RESULTED IN THE DEFINITION OF THE BASIC EXPERIMENTAL PACKAGES AND SATELLITE STRUCTURE AS DESCRIBED IN THE FINAL REPORT. THE INTERFACE DEFINITION DOCUMENT (DATED 8 NOVEMBER 1968) WAS ALSO PREPARED DURING THE PRELIMINARY DESIGN. IT IS CURRENTLY BEING UPDATED FOR RELEASE DURING THE NEXT REPORTING PERIOD. THE PRESENT CONTRACT WILL COVER THREE ADDITIONAL PHASES OF THE PROGRAM: PHAS 2 - DESIGN PHASE 3- FABRICATION, AND PHASE 4- TEST AND LAUNCH. DURING THE DESIGN PHASE THE ELECTRONIC AND MECHANICAL DESIGN OF THE ELECTRONIC PACKAGES. DURING PHASE 3 A SINGLE SATELLITE WILL BE FABRICATED TO BE USED FOR ENVIRONMENTAL AND FLIGHT ACCEPTANCE TESTS AT NASA MSC AND SUBSEQUENT LAUNCH UNDER PHASE 4. THE RMS WILL CARRY TWO EXPERIMENTS: (1) A NUCLEAR RADIATION EXPERIMENT COMPOSED OF A RADIATION SPECTROMETER, A REAL-TIME PULSE-HEIGHT SPECTRUM-TO-DOSE CONVERTER, AND THREE NASA----

RTOP NO. 709-16-02 TITLE: LRCC SPACE TECHNOLOGY SMALL FLIGHT PROJECTS

ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: SANDAHL, C. A. TEL. 703-827-3784  
TECHNICAL SUMMARY

SMALL FLIGHT PROJECTS ARE CONDUCTED AS AN INTEGRAL PART OF SPACE TECHNOLOGY RESEARCH WHERE REQUIRED TO SUPPLEMENT, PROVIDE AN INPUT TO OR FOCAL POINT FOR, GROUND TEST AND ANALYSIS OR WHERE DATA ARE REQUIRED THAT CAN BE OBTAINED ONLY IN FLIGHT. SPECIFIC EXPERIMENTS ARE CONDUCTED IN ACCORDANCE WITH CENTER PROPOSALS APPROVED BY HEADQUARTERS CURRENT ACTIVITIES INCLUDE DECELERATOR TESTS AND REENTRY HEAT SHIELD MATERIALS TESTS.

RTOP NO. 711-02-11 TITLE: PLANETARY ATMOSPHERE EXPERIMENTS TEST  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: GOODWIN, G. TEL. 415-961-2265  
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THE PLANETARY ATMOSPHERE EXPERIMENTS TEST (PAET) IS TO DEMONSTRATE IN THE EARTH'S ATMOSPHERE THE ABILITY OF SELECTED EXPERIMENTS TO DETERMINE THE STRUCTURE AND COMPOSITION OF AN UNKNOWN PLANETARY ATMOSPHERE FROM A PROBE VEHICLE ENTERING THE ATMOSPHERE AT HIGH SPEEDS. RESULTS FROM THIS TEST WILL PROVIDE FLIGHT EXPERIENCE FOR THE EVALUATION OF EXPERIMENTS APPLICABLE TO ENTRY MISSIONS TO MARS AND VENUS. THREE EXPERIMENTS WILL BE FLOWN: AN ATMOSPHERE STRUCTURE EXPERIMENT, A SHOCK-LAYER RADIOMETER COMPOSITION EXPERIMENT, AND A MASSSPECTROMETER COMPOSITION EXPERIMENT. AN ENTRY VEHICLE DESIGNED TO ACCOMMODATE THESE EXPERIMENTS WILL BE BUILT AT AMES RESEARCH CENTER. THE ENTRY VEHICLE WILL BE FLOWN FROM WALLOPS ISLAND ON A FOUR-STAGE SCOUT LAUNCH VEHICLE. ENTRY WILL OCCUR NEAR BERMUDA.

RTOP NO. 713-01-01 TITLE: METEOROID TECHNOLOGY SATELLITE  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: SANDAHL, C. A. TEL. 703-827-3784  
TECHNICAL SUMMARY

THE METEOROID TECHNOLOGY SATELLITE IS A SCOUT LAUNCHED NEAR-EARTH EXPERIMENT TO OBTAIN BASELINE DATA ON THE EFFECTIVENESS OF BUMPERS OR MULTI-WALL STRUCTURES AND THE VELOCITY DISTRIBUTION OF METEORIDS. MEASUREMENT WILL ALSO BE MADE OF THE FLUX OF VERY SMALL MASS METEORIDS. THE VELOCITY MEASUREMENT WILL BE A JOINT LARC/NSC EXPERIMENT.

RTOP NO. 720-01-10 TITLE: AERODYNAMICS OF ADVANCED SUPERSONIC TRANSPORTS

ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

THE CURRENT SUPERSONIC TRANSPORT PROGRAM HAS REACHED A STAGE WHERE RESEARCH EFFORT ON GROWTH VERSIONS SHOULD BE CONSIDERED. PRELIMINARY THOUGHTS IN THIS RESPECT REVEAL TWO AREAS OF POTENTIAL WORTHWHILE ADVANCED RESEARCH EFFORT. FIRST, DESIGN OF THE CURRENT SST HAS REVEALED AREAS IN WHICH FURTHER RESEARCH WOULD BE EXPECTED TO PRODUCE IMPROVEMENTS IN OPERATING EFFICIENCY, PERFORMANCE, AND SAFETY. SECONDLY, THE DESIRABILITY AND ADVANTAGES TO THE UNITED STATES OF DEVELOPING A DOMESTIC SST, AS DIFFERENTIATED FROM THE CURRENT INTERNATIONAL SST, SHOULD BE EXAMINED. BOTH RESEARCHES WOULD BE CARRIED OUT THROUGH INITIAL ANALYTICAL STUDIES FOLLOWED BY

SUBSTANTIATING DATA OBTAINED IN GROUND BASED FACILITIES; SUCH AS WIND TUNNELS AND FLIGHT SIMULATORS.

RTOP NO. 720-01-10 TITLE: ADVANCED SUPERSONIC TRANSPORTS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

TO DEVELOP THE AERODYNAMIC-STRUCTURES TECHNOLOGY WHICH WOULD SERVE AS A BASIS FOR AN IMPROVED SUPERSONIC TRANSPORT AIRCRAFT IN TERMS OF MAXIMUM AERODYNAMIC PERFORMANCE AT BOTH SUPERSONIC AND SUBSONIC SPEEDS AND TO PROVIDE SUFFICIENT CONTROL POWER FOR ALL PHASES OF FLIGHT. THE RESULTS COULD BE APPLIED TO PRODUCTION SUPERSONIC TRANSPORT CONFIGURATIONS. BOTH ANALYTICAL AND EXPERIMENTAL RESEARCH ON AEROELASTIC CONFIGURATIONS WILL BE CONTINUED AND SUPERSONIC AERODYNAMIC COMPUTER PROGRAMS WILL BE EXTENDED TO COVER ACCURATE WING LOAD CONDITIONS DURING MANEUVER AND UPSET CONDITIONS OF FLIGHT. OFF DESIGN CONDITIONS AT SUBSONIC AND HIGH TRANSONIC SPEEDS WILL BE DETERMINED WITH WIND-TUNNEL PRESSURE INSTRUMENTED MODELS.

RTOP NO. 720-01-11 TITLE: ADVANCED MILITARY AIRCRAFT  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

AS A CONSEQUENCE OF ITS OBLIGATION TO THE NATIONAL INTEREST AND ITS AERONAUTICAL RESEARCH COMPETENCE, THE NASA HAS MAINTAINED A CONTINUOUS COOPERATIVE EFFORT WITH THE DEPARTMENT OF DEFENSE. ONE PHASE OF THIS EFFORT IS CONCERNED WITH PROVIDING AERODYNAMIC TECHNOLOGY, IN TERMS OF DATA AND CONSULTATION, NEEDED FOR THE CONCEPTION AND DESIGN OF ADVANCED MILITARY AIRCRAFT. THIS SUPPORT ENCOMPASSES A WIDE RANGE OF ACTIVITIES, INCLUDING ANALYTICAL REVIEW, TESTING, AND CONSULTATION WITH RESPECT TO PROJECTED MILITARY AIRCRAFT, AND ALSO THEORETICAL AND EXPERIMENTAL STUDIES OF ADVANCED THEORIES OR IDEAS WHICH USUALLY PRECEDE ADVANCED MILITARY CONCEPTS.

RTOP NO. 720-01-11 TITLE: ADVANCED MILITARY AIRCRAFT  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO APPLY THE ADVANCES FROM THE FUNDAMENTAL DISCIPLINARY RESEARCH EFFORTS TO PRACTICAL AERODYNAMIC, PROPULSION, AND STRUCTURAL DESIGN TECHNIQUES TO PROVIDE EFFICIENT SUPERSONIC MILITARY AIRCRAFT AND MISSILES. CURRENT EMPHASIS IS FOCUSED ON THE USN F-14, USAF F-15, AND USAF B-1A AND A HOST OF MISSILES. FUTURE EMPHASIS WILL BE ON AMI AND THE DOGFIGHT MISSILE. WITH REGARDS TO AERODYNAMICS, THE PERFORMANCE AND STABILITY/CONTROL ARE BEING STUDIED BY USE OF AUTOMATED ANALYTIC TECHNIQUES AND WIND-TUNNEL EXPERIMENTS. INLET RESEARCH IS DIRECTED TOWARDS AN UNDERSTANDING OF THE FLOW

FIELDS GENERATED BY THE FUSELAGE AT THE INLETS OF TYPICAL MANEUVERING AIRCRAFT. ANOTHER AREA OF CONCERN IS THE PREDICTION OF THE INSTALLED DRAG OF THE INLET SYSTEM, INCLUDING INTERFERENCE EFFECTS. EXPERIMENTAL RESEARCH ON THE JET EXHAUST NOZZLE SYSTEM IS DIRECTED TOWARD THE ATTAINMENT OF IMPROVED PERFORMANCE AND AN UNDERSTANDING OF THE NOZZLE-AIRFRAME INTERFERENCE CHARACTERISTICS. A CAPABILITY TO ESTIMATE THE AIRCRAFT WEIGHT AND BALANCE CHARACTERISTICS IS BEING DEVELOPED. INITIALLY THE UNDERSTANDING AND USE OF PARAMETRIC STATISTICAL METHODS ARE BEING UNDERTAKEN. THE MORE ADVANCED TECHNIQUES WILL BE APPROACHED AS SKILL IS ACQUIRED.

RTOP NO. 720-02-10 TITLE: AEROELASTICITY OF SUPERSONIC CONFIGURATIONS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

A BETTER UNDERSTANDING OF THE AEROELASTIC CHARACTERISTICS OF SUPERSONIC CONFIGURATIONS IS REQUIRED IN ORDER TO PROVIDE SAFE, EFFICIENT SUPERSONIC AIRCRAFT. SUPERSONIC AIRCRAFT TEND TO BE LONG AND SLENDER, LEADING TO RELATIVELY FLEXIBLE DESIGNS. FLUTTER, GUST RESPONSE, AND ELASTIC EFFECTS ON STABILITY AND CONTROL CAN HAVE A SIGNIFICANT INFLUENCE ON THE DESIGN OF SUCH AIRCRAFT. THIS RESEARCH IS INTENDED TO PROVIDE INFORMATION ON THE AEROELASTIC CHARACTERISTICS IN CONFIGURATION STUDIES FOR SUCH AIRCRAFT AS THE SUPERSONIC TRANSPORT AND AMSA.

RTOP NO. 720-02-11 TITLE: MATERIALS AND STRUCTURES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVES ARE TO: INVESTIGATE ADVANCED RESINS AND ADHESIVES THAT MAY BE SUITABLE FOR USE IN SUPERSONIC AIRCRAFT STRUCTURAL APPLICATIONS. THE WORK INCLUDES DEVELOPMENT OF NEW OR ADVANCED POLYIMIDES AND PYRRONES AND EVALUATION OF THESE MATERIALS UNDER APPROPRIATE ENVIRONMENTAL TESTS. INCLUDED ALSO ARE DEVELOPMENT OF FABRICATION METHODS FOR MOLDING COMPOSITES AND FOR BONDING COMPOSITES ONTO METALS. PRIMARY INTEREST WILL BE DIRECTED AT BONDING BORON OR GRAPHITE COMPOSITES ONTO TITANIUM ALLOYS. TO INVESTIGATE THE EFFECTS OF SUPERSONIC FLIGHT ENVIRONMENT ON THE SALT STRESS CORROSION, EROSION, AND OTHER THERMAL DEGRADATION EFFECTS ON SUPERSONIC AIRCRAFT STRUCTURAL MATERIALS. OF PRIMARY CONCERN ARE AIR VELOCITIES TO MACH 3, TEMPERATURES TO 600 DEGREES F, AND ALTITUDES TO 70,000 FEET. THE MATERIALS TESTS WILL FOCUS INITIALLY ON TITANIUM ALLOYS AND WILL BE CONDUCTED IN THE RECENTLY INSTALLED MATERIALS TESTS SYSTEM SUITABLE FOR THIS TYPE OF RESEARCH. CORRELATION OF THE RESULTS WILL BE MADE WITH DATA OBTAINED IN THE LABORATORY UNDER STATIC ENVIRONMENTAL CONDITIONS. THIS WORK WILL HELP TO PROVIDE CONFIDENCE IN THE UTILIZATION OF NEW OR ADVANCED MATERIALS IN AIRCRAFT STRUCTURES THROUGH DEFINITION OF NEW RESINS OR ADHESIVES THAT WILL BE PARTICULARLY USEFUL FOR APPLICATIONS OF ADVANCED



FILAMENTARY COMPOSITES, AND WILL ALSO PROVIDE MEANINGFUL DATA ON THE SALT STRESS CORROSION PROBLEM FOR SUPERSONIC AIRCRAFT FABRICATED FROM TITANIUM ALLOYS.

RTOP NO. 720-02-12 TITLE: POLYMERS FOR FUEL TANK SEALANTS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 205-453-1120

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK ARE THE DEVELOPMENT OF THERMALLY STABLE FUEL RESISTANT BASE MATERIALS, THE CONVERSION OF THESE BASE MATERIALS INTO PRACTICAL FUEL TANK SEALANTS, AND THE DEVELOPMENT OF A TEST METHODOLOGY AND PROCEDURE THAT CAN BE APPLIED IN A SHORT TIME TO THESE AND OTHER SEALANTS.

RTOP NO. 720-02-13 TITLE: STATIC AND ELASTIC CHARACTERISTICS OF A/C STRUCTURES

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: JENKINS, J. M. TEL. 805-258-3311

TECHNICAL SUMMARY

STRUCTURES AND MATERIALS CURRENTLY USED AND CONTEMPLATED FOR THE FUTURE HAVE INDUCED SERIOUS PROBLEMS IN THE AREA OF SUPERSONIC FLIGHT. STRAIN-GAGE MEASUREMENTS CONTINUE TO PROVIDE THE MOST SIGNIFICANT INFORMATION RELATING THE PERFORMANCE OF THE STRUCTURE AND ITS FLIGHT ENVIRONMENT. RESEARCH WILL BE DIRECTED TOWARD CONTINUING TO SOLVE SUCH PROBLEMS AS THE DEVELOPMENT OF HIGH-TEMPERATURE STRAIN SENSORS, THE EFFECT OF STRAIN-GAGE INSTALLATION ON THE FATIGUE PROPERTIES OF HIGH-PERFORMANCE MATERIALS, AND THE PREDICTION TECHNIQUES OF STRESSES AND DEFLECTIONS OF COMPLEX STRUCTURES.

RTOP NO. 720-03-10 TITLE: INLETS, INLET CONTROLS, AND INLET-ENGINE DYNAMICS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVES ARE TO DEVELOP AN UNDERSTANDING OF THE INLET REQUIREMENTS FOR FUTURE AIRCRAFT, TO DETERMINE THE TYPES OF DESIGNS WHICH SATISFY THESE REQUIREMENTS, AND TO PROVIDE THE TECHNOLOGY REQUIRED TO ASSURE SUCCESSFUL OPERATION OF THESE INLETS. THE RESEARCH IS APPLICABLE TO MILITARY AND COMMERCIAL AIRCRAFT WHICH OPERATE AT SUPERSONIC SPEEDS. BOTH ANALYTICAL AND EXPERIMENTAL APPROACHES WILL BE USED TO ACHIEVE THE OBJECTIVES.

RTOP NO. 720-03-10 TITLE: INLETS, INLET CONTROLS, AND INLET-ENGINE DYNAMICS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: BELLMAN, D. R. TEL. 805-258-3311

TECHNICAL SUMMARY

AIR INTAKE PROBLEMS INCREASE GREATLY AS THE SPEED OF AIRCRAFT ADVANCE INTO THE SUPERSONIC REGION. MUCH OF THE RESEARCH IN THIS AREA MUST BE DONE IN FULL-SCALE FLIGHT BECAUSE OF UNKNOWN SCALING EFFECTS AND A LACK OF LARGE SUPERSONIC WIND TUNNELS. STATIC AND DYNAMIC CONDITIONS IN AND AROUND THE INLET AND ENGINE ARE BEING MEASURED IN FULL-SCALE FLIGHT FOR A SERIES OF SUPERSONIC AIRCRAFT. THE EFFECT OF FLOW DISTORTION AND TURBULENCE LEVELS WITHIN THE INLET ON THE JET ENGINE AND THE OCCURRENCE OF COMPRESSOR STALLS IS BEING STUDIED. INITIAL WORK IS BEING DONE ON AN F-111A AIRPLANE AND A PROGRAM ON THE YF-12 AIRPLANE IS IN THE PLANNING STAGE. LATER, IT IS HOPED TO CONTINUE THE WORK ON SUCH AIRCRAFT AS THE F-14, THE F-15, AND AMSA.

RTOP NO. 720-03-10 TITLE: INLETS, INLET CONTROLS, AND INLET ENGINE DYNAMICS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: BEHEIM, M. TEL.

TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONTINUE TO DEVELOP THE TECHNOLOGY REQUIRED FOR THE DESIGN OF INLETS AND CONTROL SYSTEMS OF FUTURE SUPERSONIC AIRCRAFT. PARTICULAR EMPHASIS WILL BE PLACED ON THE STABILITY PROBLEMS OF HIGH-PERFORMANCE INLETS AND CONTROLS AT THEIR DESIGN SPEED, ON THE PERFORMANCE AND VARIABLE-GEOMETRY PROBLEMS THAT ARE ENCOUNTERED DURING OFF-DESIGN OPERATION, AND ON THE MUTUAL INTERACTION PROBLEMS THAT RESULT WHEN INTEGRATING THESE COMPONENTS INTO A COMPLETE AIRFRAME AND PROPULSION SYSTEM. THIS EFFORT IS CLOSELY RELATED TO THE TURBOJET AND TURBOPAN ENGINE SYSTEM RESEARCH DESCRIBED IN RTOP 720-03-15, AND SEVERAL OF THE TEST MODEL COMPONENTS WILL BE USED IN BOTH PROGRAMS. RESULTS WOULD BE APPLICABLE TO SUPERSONIC DASH MILITARY AIRCRAFT AND TO SUPERSONIC CRUISE COMMERCIAL AIRCRAFT.

RTOP NO. 720-03-10 TITLE: SUPERSONIC INLETS, INLET CONTROLS, INLET-ENGINE DYNAMICS, AND RELATED PROBLEMS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

TECHNICAL SUMMARY

THE DESIGN AND OPERATION OF ENGINE AIR INLETS FOR SUPERSONIC AIRPLANES INVOLVES MANY PROBLEMS WHICH VARY IN NATURE BUT ARE, IN GENERAL, ASSOCIATED WITH ATTEMPTS TO OBTAIN A RELATIVELY UNIFORM SUPPLY OF AIR AT THE ENGINE FACE, WITH MINIMUM ENERGY LOSS TO THAT AIR, AT OFF-DESIGN AS WELL AS CRUISE SPEEDS, WITH MINIMUM MECHANICAL COMPLICATION AND WEIGHT PENALTY, AND MINIMUM DISTURBANCE TO THE EXTERNAL AERODYNAMICS OF THE AIRPLANE. CONSEQUENTLY, INLET RESEARCH

RANGES FROM BASIC AERODYNAMIC STUDIES OF BOUNDARY LAYER GROWTH AND SHOCK WAVE INTERACTION TO VARIOUS MECHANICAL-ELECTRICAL-PNEUMATIC DEVICES FOR CONTROL OF THE NORMAL SHOCK POSITION. ANALYTICAL STUDIES WITH ELECTRONIC COMPUTERS, AND EXPERIMENTAL INVESTIGATIONS IN GROUND BASED FACILITIES ARE USED TO ATTACK THESE PROBLEMS.

RTOP NO. 720-03-11 TITLE: JET EXHAUST SYSTEMS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: BEHEIM, M. TEL.

TECHNICAL SUMMARY

THE OBJECTIVE IS TO CONTINUE TO DEVELOP THE TECHNOLOGY REQUIRED FOR THE DESIGN OF NOZZLES OF FUTURE SUPERSONIC AIRCRAFT. PARTICULAR EMPHASIS WILL BE PLACED ON THE PERFORMANCE, COOLING, AND VARIABLE GEOMETRY PROBLEMS THAT ARE ENCOUNTERED DURING OPERATION OVER A BROAD RANGE OF FLIGHT SPEEDS. IN ADDITION STUDIES WILL BE MADE OF THE MUTUAL INTERACTION PROBLEMS THAT OCCUR WHEN INTEGRATING THE NOZZLE INTO A COMPLETE AIRFRAME AND PROPULSION SYSTEM. THIS EFFORT IS CLOSELY RELATED TO THE TURBOJET AND INLET SYSTEM RESEARCH DESCRIBED IN RTOP'S 720-03-10 AND 720-03-15, AND SEVERAL OF THE TEST MODEL COMPONENTS WILL BE USED IN ALL THREE PROGRAMS. RESULTS WOULD BE APPLICABLE TO SUPERSONIC DASH MILITARY AIRCRAFT AND TO SUPERSONIC CRUISE COMMERCIAL AIRCRAFT.

RTOP NO. 720-03-11 TITLE: JET EXHAUST SYSTEMS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

A PRIME GOAL OF JET EXIT RESEARCH IS TO ACHIEVE EXHAUST NOZZLE DESIGNS CAPABLE OF NEAR IDEAL CONVERSION OF THE PRESSURE AND THERMAL ENERGY OF THE ENGINE INTERNAL FLOW INTO THRUST OF THE EXHAUST JET; AND, TO DEVISE AND INVESTIGATE EXHAUST NOZZLE MECHANISMS WHICH PERMIT VARIATION OF THROAT SIZE AND NOZZLE EXPANSION RATIO TO MAINTAIN THIS NEAR IDEAL PERFORMANCE OVER ANY REQUIRED RANGE OF VEHICLE AIRSPEED AND NOZZLE PRESSURE RATIO. AN EQUALLY IMPORTANT GOAL IS REALIZATION OF SYSTEMATIC DESIGN PROCEDURES FOR INCORPORATION OF SINGLE OR MULTIPLE EXHAUST NOZZLES INTO AN AIRFRAME TO YIELD A CONFIGURATION NOT PENALIZED BY LOSS OF THRUST OR INCREASE IN DRAG RELATED TO THE EXHAUST NOZZLE INSTALLATION. A FURTHER GOAL IS CONTINUED STUDY OF BOUNDARY LAYER AND JET MIXING, AND OF JET EFFECTS ON BASE AND BOATTAIL DRAG, AND TO REDUCE TO SCIENCE THE KNOWLEDGE OF THESE MUTUAL INTERFERENCES BETWEEN EXHAUST JET PLUME, AIRFRAME, AND EXTERNAL AIRSTREAM, WITH A VIEW TO EXPLOIT THESE PHENOMENA FOR ACHIEVEMENT OF IMPROVED VEHICLE PERFORMANCE. THE TERM EXHAUST NOZZLE HERE IS MEANT TO INCLUDE JET NOISE SUPPRESSORS AND THRUST REVERSERS.

RTOP NO. 720-03-12 TITLE: COMPRESSORS AND FANS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: HARTMANN, M. J. TEL.  
TECHNICAL SUMMARY

SEVERAL APPROACHES TO REDUCE COMPRESSOR AND FAN COMPONENT WEIGHT AND IMPROVE PERFORMANCE WILL BE INVESTIGATED. THESE COMPONENTS MUST PROVIDE EFFICIENT COMPRESSION, THE NECESSARY STALL MARGIN AND DISTORTION TOLERANCE OVER THE RANGE OF FLOW RATES IMPOSED BY VARIOUS FLIGHT CONDITIONS. INCREASING STAGE PRESSURE RATIO REDUCES THE NUMBER OF BLADE ROWS NECESSARY TO PROVIDE THE OVERALL PRESSURE RATIO AND THUS REDUCES WEIGHT. A. COMPRESSOR BLADES WILL BE DESIGNED TO OPERATE AT HIGHER FLOW MACH NUMBERS ENCOUNTERED AT INCREASED ROTATIONAL SPEEDS MADE POSSIBLE BY IMPROVED MATERIALS. MULTIPLE CIRCULAR ARC BLADE SHAPE WILL BE USED FOR THESE HIGH LEVELS OF FLOW MACH NUMBER. B. INCREASING BLADE AERODYNAMIC LOADING WILL MAKE POSSIBLE THE USE OF FEWER BLADE ROWS TO OBTAIN A GIVEN OVERALL PRESSURE RATIO. VARIOUS APPROACHES TO DELAY END WALL STALL WILL BE STUDIED TO OBTAIN SUITABLE PERFORMANCE FROM THESE HIGHLY LOADED BLADE ROWS. C. A NUMBER OF ADVANCED CONCEPTS MAY BE USEFUL IN IMPROVING COMPRESSOR PERFORMANCE AND DISTORTION TOLERANCE. VARIABLE CAMBER GUIDE VANES AND STATORS WILL BE UTILIZED TO REMATCH STAGES TO IMPROVE PERFORMANCE OVER A WIDER RANGE OF FLOW CONDITIONS. VARIOUS CASING TREATMENTS WILL BE UTILIZED TO IMPROVE DISTORTION TOLERANCE AND INCREASE STALL MARGIN. A NUMBER OF THESE ADVANCED CONCEPTS FOR IMPROVING STALL MARGIN AND DISTORTION TOLERANCE MAY PROVIDE GOOD PERFORMANCE WITH HIGH ASPECT RATIO BLADING. REDUCING BLADE ROW LENGTH THROUGH HIGH ASPECT RATIO BLADES COULD SUBSTANTIALLY REDUCE COMPRESSOR WEIGHT. D. MULTISTAGE COMPRESSORS WILL INCORPORATE THE MOST PROMISING ADVANCED CONCEPT INVESTIGATED IN SINGLE STAGE COMPRESSORS.

RTOP NO. 720-03-13 TITLE: COMBUSTORS AND FUELS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: ROUDEBUSH, W. H. TEL. 000-433-4000  
TECHNICAL SUMMARY

RESEARCH PROGRAMS WILL BE CONDUCTED IN THE AREAS OF PRIMARY COMBUSTORS, AUGMENTING BURNERS AND FUELS FOR ADVANCED TURBOJET ENGINES. THE OBJECTIVE OF THE PRIMARY COMBUSTOR PROGRAM IS TO ESTABLISH THE TECHNOLOGY NECESSARY FOR THE DESIGN OF HIGH PERFORMANCE, DURABLE COMBUSTORS FOR ADVANCED COMMERCIAL AND MILITARY APPLICATIONS. A RANGE OF COMBUSTOR PRESSURES UP TO 450 PSIA, INLET TEMPERATURES UP TO 1400 DEGREES F, AND OUTLET TEMPERATURES FROM 2400 DEGREES F TO 3000 DEGREES F WILL BE INVESTIGATED. AFTERBURNERS WILL BE EVALUATED AND IMPROVED AS REQUIRED FOR ADVANCED APPLICATIONS IN HIGH TEMPERATURE TURBOJET AND TURBOPAN ENGINES. INVESTIGATIONS WILL BE CONDUCTED OVER RANGES OF THE PERTINENT ENGINE PARAMETERS SUCH AS TEMPERATURE, PRESSURE, VELOCITY, FUEL-AIR RATIO, BYPASS RATIO, ETC. THE EFFECTS OF THE VARIOUS AFTERBURNER DESIGN VARIABLES SUCH AS BLOCKAGE, FLAMEHOLDER GEOMETRY, FUEL MIXING LENGTH, STAGING, PILOTING, BURNER LENGTH, CORE AND BYPASS MIXING, ETC. WILL BE EVALUATED. FUELS PROGRAMS WILL BE CONDUCTED TO (1) DESIGN AND MODIFY AN EXPERIMENTAL ENGINE TO PERMIT ITS OPERATION ON LIQUID METHANE FUEL

USING A REALISTIC FUEL SYSTEM INCLUDING HEAT EXCHANGERS TO SIMULATE COOLING OF ENGINE COMPONENTS, (2) MAKE SIMILAR MODIFICATIONS FOR OPERATING WITH JP HEATED TO 1000 DEGREES F, (3) DESIGN AND TEST A FUEL COOLED PLUG EXHAUST NOZZLE, AND (4) DESIGN, FABRICATE AND TEST A METHANE DEMONSTRATOR ENGINE.

RTOP NO. 720-03-14 TITLE: TURBINES  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: ESGAR, J. B. TEL. 000-433-4000  
TECHNICAL SUMMARY

THE TURBINE AERODYNAMICS RESEARCH WILL UTILIZE ANALYSIS AND EXPERIMENTS ON COLD AIR TURBINES TO (1) INVESTIGATE THE AERODYNAMIC EFFECTS OF COOLING AIR DISCHARGE (USING A VARIETY OF COOLING METHODS) ON TURBINE PERFORMANCE FOR BOTH SINGLE AND MULTISTAGE TURBINES, (2) INVESTIGATE THE PERFORMANCE OF BOTH FIXED AND VARIABLE GEOMETRY TURBINES, (3) INVESTIGATE A NUMBER OF METHODS OF INCREASING BLADE LOADING IN ORDER TO REDUCE TURBINE SIZE AND HEAT TRANSFER SURFACE AREA. THE TURBINE COOLING RESEARCH IS DIRECTED TOWARDS DEVELOPING METHODS FOR PREDICTING WITH A RATHER HIGH DEGREE OF CONFIDENCE THE COOLING PERFORMANCE OF AIR COOLED TURBINE BLADES COOLED BY A VARIETY OF METHODS, DEMONSTRATING THE FEASIBILITY OF OPERATING GAS TURBINES AT VERY HIGH GAS TEMPERATURES (UP TO 3000 DEGREES F BY 1974), AND DEVELOPING IMPROVED METHODS OF FABRICATING COOLED TURBINE BLADES BY MEANS OF NOVEL CONSTRUCTION METHODS, NEW MATERIALS, AND IMPROVED BONDING TECHNIQUES. BOTH THE AERODYNAMICS AND COOLING RESEARCH ARE VERY DIRECTLY APPLICABLE TO PRESENT DEVELOPMENTAL AND FUTURE AIRCRAFT ENGINES. THE TURBINE IS UNDERGOING A GREATER CHANGE THAN ANY OTHER ENGINE COMPONENT IN MODERN ENGINES. THE TURBINE INLET TEMPERATURES ARE STEADILY INCREASING AS FAST AS THE STATE-OF-THE-ART WILL PERMIT, AND HIGH WORK TURBINES ARE BEING INTRODUCED IN ORDER TO REDUCE TURBINE WEIGHT AND SIZE AND TO REDUCE THE HEAT TRANSFER SURFACE AREA IN COOLED TURBINES.

RTOP NO. 720-03-15 TITLE: TURBINE ENGINE SYSTEMS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: POVOLNY, J. H. TEL. 000-433-4000  
TECHNICAL SUMMARY

THE ULTIMATE OBJECTIVES OF THIS PROGRAM ARE TO EFFECT AN UNDERSTANDING AND SOLUTION OF THE DYNAMIC INTERACTION PROBLEMS ASSOCIATED WITH SUPERSONIC FLIGHT. THE LATEST LARGE SCALE TURBOJET AND TURBOFAN ENGINES AND APPROPRIATE INLETS DESIGNED FOR BOTH SUPERSONIC CRUISE AND SUPERSONIC DASH APPLICATION WILL BE USED IN THE INVESTIGATIONS. BOTH EXPLORATORY AND PERFORMANCE EVALUATIONS WILL BE MADE OF SYSTEMS APPLICABLE TO THE SST AND MILITARY AIRPLANES CURRENTLY BEING DESIGNED. FACILITIES TO BE EMPLOYED IN THIS PROGRAM INCLUDE PSL, 10'X10' SWT AND THE F106 AIRPLANE. THIS INTEGRATED EFFORT IS NOT ONLY CONCERNED WITH THE EFFECTS OF THE INLET PRODUCED ENVIRONMENT ON THE ENGINE AND THE INTERACTION OF THE VARIOUS ENGINE COMPONENTS, ONE WITH ANOTHER, BUT ALSO THE INTERACTIONS BETWEEN THE ENGINE AND THE INLET. MANY OF THE INVESTIGATIONS WILL BE RELATED TO

AND RUN CONCURRENTLY WITH THOSE TASKS DESCRIBED UNDER RTOP 720-03-10.

RTOP NO. 720-04-10 TITLE: ATMOSPHERIC RESEARCH  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO OBTAIN DETAILED MEASUREMENTS OF THE COMPONENTS OF ATMOSPHERIC TURBULENCE AND RADIATION FROM GALACTIC AND SOLAR COSMIC RAYS IN THE ATMOSPHERE AT ALTITUDES UP TO 75,000 FEET. THE ATMOSPHERIC TURBULENCE MEASUREMENTS WILL BE MADE WITH AIRCRAFT CARRYING SUITABLE INSTRUMENTATION INCLUDING VANES AND A STABLE PLATFORM. THE INSTRUMENTED AIRPLANE WILL MAKE ENOUGH FLIGHTS (50 TO 60 FLIGHTS OVER A 2 YEAR PERIOD) TO OBTAIN STATISTICALLY RELIABLE SPECTRAL MEASUREMENTS. EVALUATION OF ATMOSPHERE RADIATION DATA FROM GALACTIC COSMIC RAYS AND SOLAR COSMIC RAYS WILL BE CONTINUED TO ESTABLISH THE SIGNIFICANCE OF THIS RADIATION IN RELATION TO THE SUPERSONIC TRANSPORT. INSTRUMENT REQUIREMENTS AND INSTRUMENT DEVELOPMENT FOR ON-BOARD USE BY SST AIRCRAFT WILL BE STARTED. EVALUATION OF SPACE ENVIRONMENTAL DATA, SHIELDING CALCULATIONS AND RADIATION EFFECTS FOR ATMOSPHERIC AND SPACE VEHICLES WILL BE CONTINUED.

RTOP NO. 720-05-10 TITLE: SUPERSONIC AIRCRAFT FLIGHT DYNAMICS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

GROUND-BASED, PILOTED SIMULATIONS AND IN-FLIGHT PILOTED SIMULATIONS HAVE BEEN USED FOR SOME TIME IN STUDIES OF VARIOUS FACTORS (I.E., VARIATIONS IN: PARAMETERS, AUGMENTATION SYSTEMS, COCKPIT INSTRUMENTS, TURBULENT AIR, VISIBILITY, CROSS-WIND VELOCITIES, ETC.) THAT CONTRIBUTE TO THE ESTABLISHMENT OF HANDLING QUALITIES REQUIREMENTS OF SUPERSONIC AIRCRAFT DESIGNS BOTH IN THE LOW-SPEED AREAS OF LANDING APPROACH, LANDING, TAKE-OFF AND CLIMB, AND IN THE HIGH-SPEED AREAS OF CRUISE, OVER-SPEED, ENGINE FAILURE, STABILITY AUGMENTATION SYSTEM FAILURE, ETC. THIS WORK IS DIRECTED (1) AT THE IMPROVEMENT OF TECHNOLOGY IN THIS AREA, (2) AT SUPPLYING BASIC INFORMATION USEFUL TO THE FAA IN ESTABLISHING CERTIFICATION REGULATIONS FOR SUPERSONIC TRANSPORT AIRCRAFT, AND FOR DEVELOPING REVISIONS IN CERTIFICATION TEST MANEUVERS TO PLACE THE CERTIFICATION PROCESS OF THESE AIRCRAFT ON A MORE RATIONAL BASIS, AND (3) AT SUPPLYING BASIC INFORMATION USEFUL TO MILITARY AIRCRAFT DESIGN, SUCH AS, FOR EXAMPLE, THE CARRIER LANDING APPROACH DYNAMIC REQUIREMENTS OF CARRIER FIGHTER AIRCRAFT.



RTOP NO. 720-05-10 TITLE: DEVELOPMENT OF VARIABLE STABILITY  
AIRCRAFT CONCEPTS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: PERRY, J. J. TEL. 805-258-3311

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RTOP ARE TO DEFINE CONCEPTS FOR ENHANCING THE CAPABILITIES OF THE GENERAL PURPOSE AIRBORNE SIMULATOR (GPAS) VARIABLE STABILITY AIRPLANE, TO DEVELOP THOSE CONCEPTS WHICH ARE FEASIBLE AND TO IMPLEMENT THE PRACTICAL CONCEPTS INTO THE GPAS SYSTEM. THE ULTIMATE OBJECTIVE IS TO PROVIDE THE MOST ADVANCED USA FACILITY FOR THE INVESTIGATION OF FLY CHARACTERISTICS, HANDLING QUALITIES CRITERIA AND STABILITY AUGMENTATION REQUIREMENTS FOR TRANSPORT CATEGORY AIRCRAFT. THE APPROACH IS TO DEFINE THE REQUIREMENTS FOR SYSTEMS IMPROVEMENTS, AND DESIGN MODIFICATIONS TO MEET THESE REQUIREMENTS, AND IMPLEMENT APPROVED DESIGN(S). THE ITEMS OF PRIMARY CONCERN ARE: SIDE-FORCE GENERATOR FOR IMPROVED SIMULATION OF DIRECTIONAL COCKPIT FORCES, DIRECT LIFT CONTROL TO ENHANCE THE FIDELITY OF LONGITUDINAL SIMULATIONS, AND AN IMPROVED VARIABLE FEEL SYSTEM, AN AIR-DATA SYSTEM WITH IMPROVED ALTITUDE AND ALTITUDE RATE MEASURING DEVICES, A TURBULENCE SIMULATION CAPABILITY, UPGRADING GPAS CONTROL AND COMPUTER SYSTEMS, IMPROVING THE DATA ACQUISITION SYSTEM TO PERMIT EFFICIENT COMPUTER PROCESSING OF RESEARCH, DATA, AND EXPANSION OF THE GPAS ENVELOPE TO INCLUDE THE LANDING APPROACH CONDITION.

RTOP NO. 720-06-10 TITLE: AIRCRAFT SUPPORT

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: PERRY, J. J. TEL. 805-258-3311

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PROVIDE OPERATIONAL SUPPORT FOR THE LOCKHEED JETSTAR AND THE ASSOCIATED GENERAL PURPOSE AIRBORNE SIMULATOR. THIS WILL BE DONE BY PROVIDING SUFFICIENT MAINTENANCE AND LOGISTIC SUPPORT TO MAINTAIN THIS FACILITY IN SUPPORT OF THE CENTER EFFORT.

RTOP NO. 720-52-10 TITLE: F-111 FLIGHT RESEARCH PROGRAM -  
OPERATIONAL SUPPORT

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: HUGHES, D. L. TEL. 805-258-3311

TECHNICAL SUMMARY

THIS PROGRAM COVERS THE OPERATIONAL SUPPORT OF F-111A AIRPLANE NO. 6 (S/N 639771) WHICH IS ON LOAN TO FRC AND IS BEING USED FOR BASIC RESEARCH ON ENGINE-AIRFRAME INTEGRATION PROBLEMS. THIS RTOP COVERS MAINTENANCE AND REPAIR AND THE OPERATIONAL EFFORT OF THE AIRPLANE AND INSTRUMENT SYSTEMS AND ALSO MINOR MODIFICATIONS AND CHANGES IN THE ENGINE, AIRFRAME, AND INSTRUMENTATION.

**RTOP NO. 720-52-11 TITLE: F-111 FLIGHT RESEARCH PROGRAM - LOADS AND STRUCTURES**

**ORGANIZATION: FLIGHT RESEARCH CENTER**

**MONITOR: FRIEND, E. L. TEL. 805-258-3311**

**TECHNICAL SUMMARY**

THE OBJECTIVE OF THE F-111A BUFFET PROGRAM IS TO OBTAIN DATA UTILIZING MANEUVERING FLAPS DURING TRANSONIC FLIGHT FOR VARIOUS WING-SWEEP POSITIONS. THE DATA WOULD PARTIALLY MEET THE PRESENT NEED FOR ADDITIONAL FLIGHT-BUFFET INFORMATION FOR VARIOUS WING-GEOMETRY CONFIGURATIONS. THE INFORMATION OBTAINED WOULD BE APPLICABLE FOR ADDITIONAL WIND-TUNNEL COMPARISONS AND EVALUATION OF FUTURE WING DESIGNS. INITIATION OF THIS PROGRAM IS DEPENDENT UPON MODIFICATION OF THE WING AND LIFT DEVICES TO MEET THE LOAD REQUIREMENTS OCCURRING DURING TRANSONIC-MANEUVERING FLIGHT.

**RTOP NO. 720-52-13 TITLE: FLIGHT DYNAMICS STUDIES USING AN F-111A AIRCRAFT.**

**ORGANIZATION: FLIGHT RESEARCH CENTER**

**MONITOR: SISK, T. R. TEL. 805-258-3311**

**TECHNICAL SUMMARY**

THE PROPOSED FLIGHT DYNAMICS PROGRAM CONSISTS OF THREE SEPARATE INVESTIGATIONS - (1) A HANDLING QUALITIES/FLIGHT CONTROL SYSTEM STUDY WITH DIFFERENT LEVELS OF SAS SOPHISTICATION, (2) A LANDING APPROACH VARIABLES STUDY WITH EMPHASIS ON THE BENEFITS DERIVED FROM DIRECT LIFT CONTROL, AND (3) A STUDY OF THE FACTORS AFFECTING TRACKING CAPABILITY WITH SPECIAL ATTENTION DIRECTED TO THE EFFECTS OF BUFFETING INTENSITY. THESE STUDIES ARE DESIGNED TO PROVIDE INFORMATION APPLICABLE TO THE ADVANCED FIGHTERS BEING DEVELOPED FOR THE NAVY AND AIR FORCE.

**RTOP NO. 720-53-10 TITLE: YF-12 RESEARCH PROGRAM**

**ORGANIZATION: FLIGHT RESEARCH CENTER**

**MONITOR: MATRANGA, G. J. TEL. 805-258-3311**

**TECHNICAL SUMMARY**

A/C #935 JOINT NASA/USAF TEST PROGRAM TO DEVELOP MACH 3 INTERCEPT TACTIC AND RELATED DESIGN INFORMATION. STABILITY AND CONTROL AND HANDLING QUALITIES RESEARCH PLANNED FOR THIS AIRPLANE. A/C #936 NASA RESEARCH AIRPLANE. TWO MAJOR AREAS OF RESEARCH ARE STRUCTURES AND PERFORMANCE.

**RTOP NO. 720-53-11 TITLE: SUPERSONIC AIRPLANE RESEARCH PROGRAM UTILIZING THE YF-12 AIRPLANE**

**ORGANIZATION: AMES RESEARCH CENTER**

**MONITOR: ROBINSON, R. G. TEL. 415-961-1111**

**TECHNICAL SUMMARY**

THE ACCURACY WITH WHICH AIRCRAFT PERFORMANCE CAN BE PREDICTED IS A SUBJECT OF GREAT IMPORTANCE TO THE AERONAUTICAL DESIGN ENGINEER. CONSEQUENTLY, WHEN AN AIRCRAFT ACHIEVES FLIGHT STATUS IN A REGIME

RELATIVELY UNEXPLORED, A COMPARISON OF ITS ACTUAL PERFORMANCE WITH PREDICTED PERFORMANCE CAN BE OF CONSIDERABLE VALUE. SUCH A COMPARISON REVEALS THE REGIONS WHERE ESTIMATION PROCEDURES AND GROUND-BASED TEST TECHNIQUES REQUIRE IMPROVEMENT, AS WELL AS INDICATING THOSE AREAS WHERE THE CURRENTLY EMPLOYED METHODS APPEAR ADEQUATE FOR DESIGN PURPOSES. IN VIEW OF THE FOREGOING, THEREFORE, A FLIGHT PROGRAM UTILIZING YF-12 AIRPLANES HAS BEEN INITIATED TO PROVIDE PERFORMANCE INFORMATION FOR COMPARISON WITH PREDICTIONS BASED ON THEORY AND DATA FROM GROUND-BASED TEST FACILITIES. THE RESEARCH PROGRAM UTILIZING YF-12 AIRPLANES HAS NOT YET BEEN COMPLETELY DEFINED, HENCE AMES PARTICIPATION AS OUTLINED IN THIS RTOP IS SUBJECT TO SOME MODIFICATION AS THE DETAIL OF THE PROGRAM BECOMES ESTABLISHED.

RTOP NO. 720-53-11 TITLE: YF12 RESEARCH  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: BEHEIM, M. TEL.  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO ESTABLISH THE PERFORMANCE AND CONTROL CHARACTERISTICS OF THE PRESENT PROPULSION SYSTEM WHEN SUBJECTED TO INFLIGHT TRANSIENT DISTURBANCES, AND TO EXPLORE THE FEASIBILITY OF APPLYING ADVANCED CONCEPTS FOR SHOCK STABILIZATION AND FOR OVERALL PROPULSION SYSTEM AND AIRFRAME CONTROL. THIS EFFORT COMPLEMENTS THE INLET AND ENGINE RESEARCH DESCRIBED IN RTOP'S 720-03-10 AND 720-03-15 IN THAT IT WOULD PROVIDE A FLIGHT DEMONSTRATION OF CONCEPTS WHICH HAVE BEEN DEVELOPED IN GROUND TEST FACILITIES.

RTOP NO. 720-53-11 TITLE: YF-12A RESEARCH PROGRAM--DISCIPLINARY  
RESEARCH  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: MATRANGA, G. J. TEL. 805-258-3311  
TECHNICAL SUMMARY

A/C #935 JOINT NASA/USAF TEST PROGRAM TO DEVELOP MACH 3 INTERCEPT TACTICS AND RELATED DESIGN INFORMATION. STABILITY AND CONTROL AND HANDLING QUALITIES RESEARCH PLANNED FOR THIS AIRPLANE. A/C #936 NASA RESEARCH AIRPLANE. TWO MAJOR AREAS OF RESEARCH ARE STRUCTURE AND PERFORMANCE.

RTOP NO. 721-01-10 TITLE: AERODYNAMIC CHARACTERISTICS OF  
PROPELLERS, ROTORS AND ROTORCRAFT  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

A JOINT NASA/ARMY PROGRAM IS DIRECTED TOWARD A "JET-FLAP" HELICOPTER ROTOR, IN WHICH A SHEET OF AIR IS BLOWN FROM THE TRAILING EDGE OF THE ROTOR BLADES, AND IN WHICH PITCH CONTROL IS OBTAINED

THROUGH DEFLECTION OF THE "JET-FLAP". THE INVESTIGATION CONSISTS OF ANALYTICAL STUDIES AND STATIC AND WIND-TUNNEL TESTS. THIS METHOD OF PROPULSION AND CONTROL OFFERS THE POSSIBILITY OF REDUCED COMPLEXITY, HIGHER SPEEDS, AND LESS VIBRATION THAN WITH PRESENT TECHNOLOGY. THE PRACTICAL ASPECTS OF INCORPORATING THE "JET-FLAP" ROTOR INTO A COMPLETE VEHICLE ARE BEING INVESTIGATED. VARIOUS STOPPABLE ROTOR CONFIGURATIONS ARE BEING INVESTIGATED BY ANALYTICAL STUDIES AND IN THE WIND TUNNEL. THESE INCLUDE MEASUREMENTS OF ROTOR LOADS AND SHAFT MOMENTS AT VARIOUS COMBINATIONS OF ANGLE OF ATTACK AND ADVANCE RATIOS TO DETERMINE APPROPRIATE ROTOR CONTROL TECHNIQUES TO BE USED DURING THE ROTOR START-STOP PROCESS. THE WORK IS A COOPERATIVE EFFORT BY NASA AND THE ARMY. VARIOUS V/STOL AIRCRAFT PROPELLERS ARE BEING INVESTIGATED IN THE WIND TUNNEL, IN COOPERATION WITH AIR FORCE PROPELLER PROGRAMS, TO OBTAIN CHARACTERISTICS OF V/STOL AIRCRAFT PROPELLERS AND TO OBTAIN DATA FOR COMPARISON OF PROPELLER CHARACTERISTICS WITH PREDICTION BY ANALYTICAL METHODS.

RTOP NO. 721-01-10 TITLE: AERODYNAMICS OF PROPELLERS AND ROTORS  
ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

A CONTINUING RESEARCH EFFORT WILL BE MAINTAINED TO ASCERTAIN THE EFFECTIVENESS OF EXISTING THEORIES, EXTEND THE CAPABILITIES OF THEORETICAL METHODS, AND PROVIDE PROCEDURES FOR ANALYZING AND PREDICTING THE AERODYNAMIC AND PERFORMANCE CHARACTERISTICS OF ROTORS AND PROPELLERS. EXPERIMENTAL STUDIES WITH VARIOUS ADVANCED ROTOR AND PROPELLER CONCEPTS, INCLUDING SOME BASED ON NEW AIRFOIL TECHNOLOGY WILL BE UNDERTAKEN TO PROVIDE IMPROVED BASIC PERFORMANCE CHARACTERISTICS. ANALYSIS AND STUDY OF THE JET-FLAP ROTOR APPLICATIONS WILL BE MADE IN AN EFFORT TO BETTER UNDERSTAND AND OFFSET JET-DRIVE POWER LOSSES BY IMPROVED LIFT DISTRIBUTION AND WAKE INTERACTIONS. EXPERIMENTAL STUDIES WILL BE MADE OF VARIOUS PROMISING V/STOL AIRCRAFT CONFIGURATIONS, SUCH AS TILT PROP-ROTOR, UNLOADED ROTOR AND STOPPED ROTOR TYPES IN BOTH HOVERING AND HIGH SPEED FLIGHT REGIMES. PARTICULAR EMPHASIS WILL BE PLACED ON THOSE AREAS WHICH MAY PROVIDE IMPROVEMENTS IN HOVER AND HOT WEATHER PERFORMANCE, PROPELLER AND ROTOR NOISE, PARTICULARLY BLADE SLAP AND VIBRATORY AIRLOADS.

RTOP NO. 721-01-11 TITLE: V/STOL AND STOL AERODYNAMICS  
ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE BASIC RESEARCH OBJECTIVE IS TO DEVELOP THE TECHNOLOGY REQUIRED FOR IMPROVED PERFORMANCE AND STABILITY AND CONTROL OF VTOL AND STOL AIRCRAFT CONFIGURATIONS THAT WOULD HAVE APPLICATION IN MILITARY AND CIVIL TRANSPORT AND IN MILITARY FIGHTER AND ATTACK MISSIONS. THE RESEARCH IS DIRECTED ALONG TWO LINES. THE MORE FUNDAMENTAL LINE IS TO PROVIDE A BASIC UNDERSTANDING OF THE AERODYNAMIC PHENOMENA INVOLVED AND TO DEVELOP THEORETICAL OR SEMI-EMPIRICAL MEANS OF PREDICTING THE AERODYNAMIC CHARACTERISTICS OF

THE VEHICLES. THE OTHER LINE IS TO EXPLORE EXPERIMENTALLY THE AERODYNAMIC CHARACTERISTICS OF THE MORE NOVEL TYPES OF VEHICLES INVOLVED WITH A VIEW TOWARD DEFINING THEIR GROSS CHARACTERISTICS, THE PERTINENT VARIABLES, AND THE PROBLEM AREAS AND GENERAL METHODS OF SOLUTION. WIND-TUNNEL AND THEORETICAL STUDIES WILL BE USED TO IMPROVE THE CAPABILITY TO PREDICT THE AERODYNAMIC PERFORMANCE AND STABILITY AND CONTROL CHARACTERISTICS OF THE ROTOR, TURBOPROP, TURBOPAN, AND TURBOJET POWERED VTOL AND STOL CONCEPTS AS THEY ARE PRESENTLY ENVISIONED, AND TO EXPLORE NEW AIRFRAME-PROPULSION INTEGRATION CONCEPTS AIMED AT IMPROVEMENT IN PERFORMANCE.

RTOP NO. 721-01-11 TITLE: V/STOL AND STOL AIRCRAFT AERODYNAMICS  
ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

TECHNICAL SUMMARY

RESEARCH IS UNDERWAY ON THE AERODYNAMIC AND PROPULSION INTEGRATION CHARACTERISTICS OF A NUMBER OF PROMISING CONCEPTS. V/STOL CONCEPTS INCLUDE TILT-WING, JET-LIFT, DUCTED-FAN, AND FAN-IN-WING CONFIGURATIONS. STOL CONCEPTS INCLUDE DEFLECTED SLIPSTREAM AND ROTATING CYLINDER FLAP PROPELLER-DRIVEN CONFIGURATIONS, AND EXTERNALLY-BLOWN FLAP, JET-FLAP (UTILIZING THE HUNTING-126 AIRCRAFT), AND HIGH-ENERGY JET EJECTOR CONFIGURATIONS FOR JET-POWERED AIRCRAFT. THE RESEARCH IS BEING CONDUCTED BY A VARIETY OF ANALYTICAL STUDIES, SMALL-SCALE TESTS WHERE APPLICABLE IN THE AARL 7- BY 10-FOOT WIND TUNNEL AND OTHER WIND TUNNELS, AND LARGE-SCALE INVESTIGATIONS USING THE 40- BY 80-FOOT WIND TUNNEL AND THE V/STOL STATIC TEST FACILITY. THE INVESTIGATIONS ARE BEING CARRIED OUT TO PROVIDE BACKGROUND TECHNOLOGY FOR V/STOL AND STOL AIRCRAFT DESIGN AND TO DEVELOP ANALYTICAL METHODS OF PREDICTING AERODYNAMIC AND PROPULSIVE INTERACTION EFFECTS.

RTOP NO. 721-01-12 TITLE: STOL TEST TECHNIQUES AND FACILITY CONCEPTS  
ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE DEFLECTION OF SLIPSTREAMS OR JET EFFLUX AT LARGE ANGLES TO THE MAIN STREAM (DIRECTION OF FLIGHT IN FREE AIR) TO OBTAIN LIFT ON V/STOL CONFIGURATIONS AT LOW SPEEDS RESULTS IN LARGE DISTORTIONS OF THE SURROUNDING FLOW AND LARGE EFFECTS OF THE TEST SECTION WALLS IN WIND TUNNEL TESTS OF THESE CONFIGURATIONS. ADEQUATE PREDICTION OF THE CHARACTERISTICS OF FULL-SCALE V/STOL AIRPLANES REQUIRES CORRECTION OF THE WIND-TUNNEL DATA FOR THESE EFFECTS. IN-HOUSE AND UNIVERSITY-GRANT EXPERIMENTAL AND ANALYTICAL STUDIES DIRECTED AT DEVELOPING IMPROVED UNDERSTANDING OF WALL EFFECTS; TO DEVISE IMPROVED THEORIES TO CORRECT FOR THESE EFFECTS; AND TO DEVELOP TEST SECTION CONFIGURATIONS THAT MINIMIZE WALL EFFECTS WILL BE CONTINUED. UNDER EXTREME CONDITIONS, THE FLOW IN THE TEST SECTION BECOMES SO DISTORTED THAT IT BREAKS DOWN AND CORRECTIONS ARE NO LONGER POSSIBLE. IN-HOUSE AND UNIVERSITY-GRANT STUDIES WILL BE CONTINUED TO IMPROVE METHODS OF PREDICTING AND DETERMINING THE BREAKDOWN POINT AND TO DEVISE TEST

**TECHNIQUES AND TEST SECTION CONFIGURATIONS TO DELAY THE BREAKDOWN POINT.**

**RTOP NO. 721-02-10 TITLE: ROTOR LOADS AND STRUCTURES**

**ORGANIZATION: AMES RESEARCH CENTER**

**MONITOR: ROBINSON, R. G. TEL. 415-961-1111**

**TECHNICAL SUMMARY**

A NASA/ARMY/ONERA TILT-ROTOR PROGRAM IS UNDERWAY FOR INVESTIGATION OF PERFORMANCE AND AEROELASTIC PREDICTION TECHNIQUES ON TILT-ROTOR DESIGN. BOEING-VERTOL IS THE CONTRACTOR (NAS2-5025) FOR THREE 13-FT-DIAMETER RIGID ROTORS, HAVING DIFFERENT TWIST DISTRIBUTIONS THAT HAVE BEEN INVESTIGATED AT SPEEDS UP TO 175 KNOTS IN THE AMES 40- BY 80-FOOT WIND TUNNEL, AND ARE BEING INVESTIGATED IN THE ONERA MODANE 26-FT WIND TUNNEL AT SPEEDS FROM APPROXIMATELY 200 TO 500 KNOTS TO DETERMINE THE EFFECTS OF COMPRESSIBILITY ON CENTER-OF-PRESSURE MOVEMENT AND TORSIONAL DISTORTION NEAR THE ROTOR TIPS. FIVE-FT-DIAMETER ROTORS HAVE BEEN INVESTIGATED IN THE ARMY AERONAUTICAL RESEARCH LABORATORY 7- BY 10-FOOT WIND TUNNEL AT AMES TO DETERMINE THE EFFECTS OF SCALE AND REYNOLDS NUMBER ON ROTOR PERFORMANCE. VARIOUS STOPPABLE ROTOR CONFIGURATIONS ARE BEING INVESTIGATED BY ANALYTICAL STUDIES AND IN THE WIND TUNNEL. THESE INCLUDE MEASUREMENTS OF ROTOR LOADS AND SHAFT MOMENTS AT VARIOUS COMBINATIONS OF ANGLE OF ATTACK AND ADVANCE RATIOS TO DETERMINE APPROPRIATE ROTOR CONTROL TECHNIQUES TO BE USED DURING THE ROTOR START-STOP PROCESS.

**RTOP NO. 721-02-10 TITLE: ROTOR LOADS AND STRUCTURES**

**ORGANIZATION: LANGLEY RESEARCH CENTER**

**MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285**

**TECHNICAL SUMMARY**

THE PRIMARY OBJECTIVE OF THIS WORK IS THE INVESTIGATION, DEFINITION, CONTROL, AND ALLEVIATION OF ROTOR SYSTEM VIBRATION, INSTABILITIES AND OSCILLATORY STRESSES. THE CONCERN IS WITH ALL NONSTEADY PHENOMENON WHICH LIMIT THE UTILIZATION OF THE ROTOR SYSTEM.

THE BASIC PROBLEM STEMS FROM OPERATING A FLEXIBLE ROTOR SYSTEM IN A SELF-INDUCED TURBULENT ENVIRONMENT. THE PROBLEMS HAVE BEEN DEALT WITH IN THE PAST WITH LIMITED SUCCESS ON SPECIFIC CONFIGURATIONS. THE FUTURE PROMISES INCREASED DIFFICULTY WITH THE EVER-INCREASING FORWARD SPEEDS THAT ARE BEING PROPOSED. THE PROBLEMS ASSOCIATED WITH A ROTOR FLYING IN ITS OWN WAKE HAVE PREVENTED THE UTILIZATION OF THE ROTORS FULL PERFORMANCE CAPABILITY. RESEARCH FOCUSED UPON THE BASIC PROBLEM OF ROTOR VIBRATION AND AEROELASTIC INSTABILITIES WILL HAVE APPLICATION TO ROTOR SYSTEM DESIGN CONCEPTS RANGING FROM THE PURE HELICOPTER TO COMPOUND, TILT-ROTOR, SLOWED ROTOR, AND STOPPED ROTOR. THE APPROACH TAKEN IN THIS AREA OF RESEARCH IS TO FOCUS PRIMARY ATTENTION ON THE NONSTEADY AERODYNAMICS, SUCH AS WAKE INTERACTION, TIP-VORTEX FLOW, AND OSCILLATING AIRFOIL STUDIES. THE CRITICAL NEED IS IN THE AREA OF DEFINING THE AERODYNAMIC ENVIRONMENT OF THE ROTOR. A CLOSELY ASSOCIATED AREA OF WORK IS IN ROTOR SYSTEM AEROELASTIC STABILITY AND MECHANICAL STABILITY, WHICH DETERMINE THE SUCCESS OF A



DESIGN IN REGARD TO SUCH THINGS AS FLUTTER, TORSIONAL DIVERGENCE, ROTOR WHIRL, AND GROUND/AIR RESONANCE. RESEARCH IS PLANNED IN THE AREAS OF ANALYTICAL STUDIES, WIND TUNNEL TESTS OF MODEL AND LARGE SCALE ROTORS, TOWER TESTS, AND FLIGHT TESTS. BASIC AERODYNAMIC RESEARCH IS INCLUDED, SUCH AS BLADE TIP-VORTEX STUDIES TO FIND WHAT MIGHT BE DONE TO CONTROL AND ALLEVIATE A PRINCIPAL SOURCE OF ROTOR IMPULSIVE LOADINGS. ROTOR CONTROL SYSTEM MECHANICAL AND AEROELASTIC STABILITY STUDIES ARE PLANNED TO SOLVE THE PROBLEM OF CONTROL OF HIGH SPEED ROTOR SYSTEMS. THE DEFINITION OF THE AEROELASTIC STABILITY OF TILT-ROTORS IS TO BE STUDIED BY MODEL TESTING IN THE LANGLEY TRANSONIC-DYNAMICS TUNNEL----

RTOP NO. 721-03-10 TITLE: V/STOL PROPULSION SYSTEMS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: LIEBLEINS, S. TEL. 216-433-4000  
TECHNICAL SUMMARY

THE OBJECTIVE OF THE EFFORT IS TO PROVIDE CONCEPTS, DESIGN AND PERFORMANCE DATA, AND ADVANCED TECHNOLOGY FOR PROPULSION SYSTEMS APPLICABLE TO THE MAJOR CIVILIAN AND MILITARY STOL AND VTOL MISSIONS.

THE PRIMARY APPLICATION CONSIDERED FOR V/STOL IS A CIVIL AIR TRANSPORTATION SYSTEM SUITABLE FOR SHORT-HAUL SERVICE INTO CITIES. THE OVERALL GOAL IS TO PROVIDE NEW AND IMPROVED COMBINED PROPULSION AND AIRFRAME CONCEPTS FOR EFFICIENT V/STOL SERVICE, WITH PRINCIPAL EMPHASIS ON THE APPLICATION OF HIGH-BYPASS-RATIO FAN SYSTEMS TO STOL AND VTOL TRANSPORTS. THE EFFORT WILL BE BASED INITIALLY ON EXPERIMENTAL EVALUATIONS OF ADVANCED COMPONENTS, CONCEPTS, AND INTEGRATED MODEL PROPULSION SYSTEMS BOTH STATICALLY AND IN THE LERC 9' X 15' V/STOL WIND TUNNEL.

RTOP NO. 721-03-10 TITLE: ADVANCED LIFT FANS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

STUDIES ARE BEING CARRIED OUT TO INVESTIGATE THE CHARACTERISTICS OF IMPROVED LIFT FANS. SOME OF THE STUDIES ARE ANALYTICAL AND ARE MADE BY CONTRACT AND DEAL WITH THE USE OF ADVANCED TECHNOLOGY TO IMPROVE LIFT-FAN PERFORMANCE, LIFT-FAN SIZE, AND LIFT-FAN WEIGHT. BASED ON SOME STUDIES MADE, TWO LIFT FANS OF 1.3 PRESSURE RATIO ARE BEING PROCURED AND WILL BE USED IN INVESTIGATIONS ON THE V/STOL STATIC TEST STAND AND IN THE 40- BY 80-FOOT WIND TUNNEL TO STUDY LIFT-FAN PERFORMANCE AS COMPARED WITH PREDICTED CHARACTERISTICS, AND TO STUDY LIFT-FAN AND AIRFRAME INTERACTION EFFECTS, PARTICULARLY IN THE CROSS-FLOW CONDITION THAT EXISTS IN TRANSITION FROM VTOL FLIGHT TO NORMAL HORIZONTAL FLIGHT. THE INTERACTION EFFECTS ARE IMPORTANT TO LIFT-FAN DESIGN AND LIFT-FAN INLET DESIGN.

RTOP NO. 721-03-11 TITLE: JET LIFT ENGINES  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE BROAD OBJECTIVE IS TO DEVELOP THE TECHNOLOGY REQUIRED FOR THE ALLEVIATION OF HOT EXHAUST GAS REINGESTION BY V/STOL AIRCRAFT WHICH CAUSES SERIOUS LOSS IN ENGINE THRUST FOR V/STOL OPERATION AND MAY EVEN CAUSE FAILURE OF THE ENGINE TO CONTINUE TO OPERATE. SPECIFIC OBJECTIVES ARE TO DEFINE THE PROBLEM AND THE GENERAL MECHANISM INVOLVED, TO DEVELOP PROCEDURES FOR INVESTIGATION AT MODEL SCALE, AND TO DEVISE AIRCRAFT CONFIGURATION FIXES AND OPERATIONAL TECHNIQUES TO ALLEVIATE THE INGESTION. THE APPROACH IS MODEL-SCALE TESTING, LIMITED LARGE-SCALE TESTING FOR CORRELATION WITH THE MODEL TESTS, AND THEORETICAL ANALYSIS. THE TESTS WILL BE CARRIED OUT FOR A RANGE OF ENGINE INLET AND NOZZLE LOCATIONS, AND FOR A RANGE OF OPERATING CONDITIONS OF RELATIVE WIND AND TAKE-OFF PATHS.

RTOP NO. 721-04-10 TITLE: VTOL AND STOL AIRCRAFT NOISE REDUCTION  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

THE 40- BY 80-FOOT WIND TUNNEL IS BEING EQUIPPED TO PERMIT NOISE MEASUREMENTS TO BE MADE DURING INVESTIGATIONS OF VARIOUS VTOL AND STOL CONCEPTS, AND CALIBRATION OF NOISE MEASURED THE WIND TUNNEL TO THE VALUES IN NORMAL OPERATING ENVIRONMENT IS BEING MADE. RESEARCH IS BEING CARRIED OUT LEADING TO REDUCED NOISE FROM HELICOPTER ROTORS. THIS RESEARCH INCLUDES THE STUDY OF THE EFFECTS OF VARIOUS KINDS OF ROTOR TIP GEOMETRY, AND THE EFFECT OF COMB-LIKE TEETH ON ROTOR BLADE LEADING EDGES. AS A FOLLOW-ON TO A CONTRACTED STUDY, CARRIED OUT TO INVESTIGATE TECHNIQUES TO REDUCE LIFT-FAN NOISE, A 1.3-PRESSURE-RATIO LIFT FAN IS BEING MODIFIED TO INCORPORATE NOISE REDUCTION FEATURES, AND INVESTIGATIONS WILL BE MADE TO MEASURE THE NOISE WITHOUT NOISE-REDUCTION FEATURES AND WITH NOISE-REDUCTION FEATURES INCORPORATED.

RTOP NO. 721-04-10 TITLE: V/STOL NOISE REDUCTION  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO PROVIDE INFORMATION NECESSARY FOR THE DESIGN OF V/STOL VEHICLES HAVING ACCEPTABLE NOISE CHARACTERISTICS. PROPULSION SYSTEM COMPONENTS, WHICH ARE PARTICULARLY APPLICABLE TO V/STOL VEHICLES, SUCH AS HELICOPTER MAIN AND TAIL ROTORS, TILTABLE PROPELLERS, DEFLECTED JETS, LIFT JETS, LIFT FANS, AND JET FLAPS WILL BE CONSIDERED, AS WELL AS THE APPLICATION OF NOISE REDUCTION MATERIALS AND SUPPRESSORS. THIS WORK WILL BE ACCOMPLISHED BY MEANS OF THEORETICAL STUDIES AND BOTH MODEL AND FULL-SCALE TESTS INVOLVING VEHICLES IN FLIGHT, WIND TUNNELS, TEST STANDS, AND SPECIAL ACOUSTIC TEST CELLS, FACILITIES AND EQUIPMENT. BOTH IN-HOUSE AND CONTRACT WORK WILL BE SUPPORTED.

FTOP NO. 721-05-10 TITLE: V/STOL AND STOL FLIGHT CHARACTERISTICS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

V/STOL AIRCRAFT HAVE THE POTENTIAL FOR SAFE FOUL-WEATHER OPERATION, EVEN INTO SMALL AREAS AS ON TO ROOFTOPS IN CONGESTED LOCATIONS. CONVENTIONAL OPERATING TECHNIQUES, CURRENTLY AVAILABLE INSTRUMENTATION AND GUIDANCE PRACTICES, AND THE GENERAL FLIGHT CHARACTERISTICS OF EXISTING V/STOL VEHICLES AT LOW SPEEDS DO NOT PRESENTLY PERMIT ADEQUATE REALIZATION OF THIS POTENTIAL. THE RESEARCH PROJECTS WILL PROVIDE THE BACKGROUND KNOWLEDGE NEEDED TO ESTABLISH V/STOL OPERATIONAL REQUIREMENTS WITH RESPECT TO THE AIRCRAFT CONTROL AND STABILITY, FLIGHT CONTROL SYSTEM CHARACTERISTICS, GUIDANCE INFORMATION, COCKPIT DISPLAYS, AIRSPACE REQUIREMENTS, PILOTING TECHNIQUES AND WORKLOADS. PARTICULAR EMPHASIS WILL BE ON THE OPERATIONAL REQUIREMENTS FOR CONVERSION FROM WINGBORNE TO POWERED-LIFT FLIGHT AND IN-FLIGHT DECELERATION TO LOW TOUCHDOWN SPEEDS OR HOVER DURING PRECISION GUIDED INSTRUMENT APPROACHES TO THE LANDING AREA. ANALYTICAL, SIMULATION, WIND-TUNNEL, AND FLIGHT STUDIES WILL BE MADE TO ACCUMULATE THE DATA AND UNDERSTANDING REQUIRED TO ESTABLISH APPROPRIATE CRITERIA AND POSSIBLE MEANS FOR IMPROVED FLIGHT CHARACTERISTICS FOR THE VARIOUS V/STOL AIRCRAFT CONCEPTS.

RTOP NO. 721-05-10 TITLE: V/STOL AND STOL AIRCRAFT FLIGHT DYNAMICS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-916-1111  
TECHNICAL SUMMARY

GROUND-BASED SIMULATORS, VARIABLE STABILITY AIRCRAFT, VARIOUS CONCEPTUAL TYPES OF AIRCRAFT, ESPECIALLY EQUIPPED AIRCRAFT, AND ANALYTICAL STUDIES ARE USED TO EXTEND KNOWLEDGE OF V/STOL AIRCRAFT FLIGHT DYNAMICS REQUIREMENTS AND MEANS OF MEETING THE REQUIREMENTS. GROUND-BASED SIMULATION IS USED TO STUDY A WIDE VARIATION OF SYSTEM PARAMETERS THAT AFFECT FLIGHT DYNAMICS AND FLIGHT OF ACTUAL AIRCRAFT IS USED TO VERIFY DISCRETE POINTS. RESULTS ARE ANALYZED AS TO THEIR RELATION TO FAA CERTIFICATION OF V/STOL AIRCRAFT. THE STUDIES INCLUDE THE RELATION OF COCKPIT DISPLAYS AND HUMAN OPERATOR CONTROL CHARACTERISTICS AND PERFORMANCE AS PART OF THE COMPLETE FLIGHT DYNAMICS SYSTEM, AND ARE INTIMATELY RELATED TO OPERATIONS UNDER INSTRUMENT CONDITIONS. PARTICULARLY UNDER TERMINAL AREA GUIDANCE FOR LANDING AND TAKE-OFF. THE MOVING-CAB TRANSPORT SIMULATOR AND THE SIX-DEGREE-OF-FREEDOM MOTION SIMULATOR ARE THE GROUND-BASED SIMULATORS USED TO STUDY A WIDE RANGE OF SYSTEM PARAMETERS. THE X-14 VARIABLE STABILITY VTOL AIRCRAFT PROVIDES FLIGHT VERIFICATION OVER CONSIDERABLE RANGE OF PARAMETERS. THE XV-5B FAN-IN-WING AIRCRAFT PERMITS STUDY OF THE RELATION OF THE OPERATIONAL ENVELOPE OF THIS CONCEPT OF AIRCRAFT TO THE EASE OF PERFORMING PRECISE APPROACHES FOR TERMINAL AREA OPERATIONS. A C-8A AIRCRAFT IS BEING USED PARTICULARLY FOR STUDIES TO DEVELOP CERTIFICATION CRITERIA AND TO DEFINE GUIDANCE AND DISPLAY REQUIREMENTS FOR IFR STOL OPERATIONS. THE HUNTING-126 JET-FLAP AIRCRAFT WILL BE INVESTIGATED TO PROVIDE DATA ON THE AERODYNAMICS, AND STABILITY AND CONTROL CHARACTERISTICS THAT WILL BE

USEFUL IN THE DESIGN OF JET-POWERED STOL AIRCRAFT. A CONVAIR 340 AIRCRAFT EQUIPPED AS A FLYING LABORATORY IS PRESENTLY BEING USED IN A FLIGHT PROGRAM TO SUPPLEMENT GROUND-BASED SIMULATOR STUDIES OF AN INSTRUMENT LANDING SYMBOLIC DISPLAY FOR STOL AIRCRAFT, AS PART OF RESERRCH WORK DIRECTED AT BETTER PILOT DISPLAYS AND SYSTEMS FOR TERMINAL AREA OPERATIONS UNDER INSTRUMENT CONDITIONS.

RTOP NO. 721-05-11 TITLE: V/STOL AND STOL FLIGHT CHARACTERISTICS  
ORGANIZATION: HEADQUARTERS  
MONITOR: KAYTEN, G. TEL. 202-963-7335  
TECHNICAL SUMMARY

FLIGHT RESEARCH IS BEING CARRIED OUT AT AMES AND LANGLEY WITH NASA V/STOL AIRCRAFT TO STUDY TERMINAL-AREA OPERATION PROBLEMS OF SUCH AIRCRAFT. AS PART OF THE OVERALL INVESTIGATION, THE NAVY X-22 TILT-DUCT VARIABLE-STABILITY AIRPLANE IS ALSO BEING UTILIZED IN A JOINT PROGRAM WITH THE NAVY AND AIR FORCE. THE FY 70 PROGRAM IS A CONTINUATION OF THE STUDY INITIATED IN 1969, ON THE BASIC UNAUGMENTED X-22. THE VARIABLE-STABILITY FEATURE WILL PERMIT COVERAGE IN FY 70 AND LATER OF A WIDER RANGE OF SIGNIFICANT FLIGHT PARAMETERS AND BETTER CORRELATION WITH FLIGHT AND SIMULATOR STUDIES OF OTHER AIRCRAFT.

RTOP NO. 721-06-10 TITLE: VTOL AND STOL AIRCRAFT SUPPORT  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

THE FOLLOWING AIRCRAFT ARE USED IN FLIGHT INVESTIGATIONS OF VTOL AND STOL AIRCRAFT 1. X-14A JET-LIFT VTOL AIRCRAFT WITH AN ATTITUDE-STABILIZED VARIABLE STABILITY SYSTEM. 2. XV-5B FAN-IN-WING VTOL AIRCRAFT 3. C-8A STOL AIRCRAFT 4. OH-12A HELICOPTER 5. OV-10A AIRCRAFT TO BE MODIFIED TO INCORPORATE A ROTATING CYLINDER FLAP.

RTOP NO. 721-06-10 TITLE: V/STOL AIRCRAFT SUPPORT  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

MAINTENANCE AND OPERATION OF AIRCRAFT FOR V/STOL RESEARCH PROGRAMS.

RTOP NO. 721-51-10 TITLE: ROTATING CYLINDER FLAP RESEARCH AIRCRAFT,  
OV-10A  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

THE PROGRAM IS A JOINT NASA/ARMY EFFORT TO DETERMINE, IN FLIGHT, THE PREDICTED CHARACTERISTICS OF THE ROTATING CYLINDER FLAP CONCEPT

AS APPLIED TO PROPELLER-DRIVEN AIRCRAFT OF RELATIVELY LOW GROSS WEIGHTS AND WING LOADINGS, AND TO DEFINE AND RESOLVE OPERATIONAL PROBLEMS. MODIFICATIONS ARE TO BE MADE TO THE AMES OV-10A AIRCRAFT TO MEET THE PROGRAM OBJECTIVES; THE MODIFICATIONS CONSIST OF A ROTATING-CYLINDER FLAP SYSTEM LARGER ENGINES, PROPELLER INTERCONNECT, AND IMPROVED LOW-SPEED CONTROLS. THE STEPS IN THE PROGRAM ARE (1) WIND-TUNNEL TESTS OF A LARGE SCALE MODEL TO PROVIDE DETAILED AERODYNAMIC DESIGN INFORMATION, (2) DESIGN FEASIBILITY STUDY UNDER CONTRACT, (3) DETAILED DESIGN, FABRICATION OF COMPONENTS, MODIFICATION OF AIRCRAFT, GROUND AND WIND-TUNNEL TESTS OF MODIFIED AIRCRAFT, AIRWORTHINESS FLIGHT TESTS BY CONTRACTOR, AND (4) A PROOF-OF-CONCEPT FLIGHT RESEARCH PROGRAM (CONSISTING OF (A) DETERMINATION OF THE AERODYNAMIC PERFORMANCE OF THE ROTATING-CYLINDER FLAP CONCEPT, AND (B) A STUDY OF THE STABILITY, CONTROL AND HANDLING QUALITIES OF THE MODIFIED AIRCRAFT.). THE PROGRAM IS BEING UNDERTAKEN BECAUSE OF THE NEED FOR PROPELLER STOL AIRCRAFT TO SOLVE BOTH CIVIL AND MILITARY AIR TRANSPORTATION PROBLEMS. THE ROTATING-CYLINDER FLAP CONCEPT HAS BEEN SELECTED BECAUSE THE RESULTS OF WIND-TUNNEL INVESTIGATIONS OF ADVANCED HIGH-LIFT DEVICES FOR PROPELLER STOL AIRCRAFT HAVE SHOWN THAT THE CONCEPT IS AS EFFECTIVE AS THE MOST EFFECTIVE BOUNDARY-LAYER-CONTROL FLAP AND REQUIRES LESS POWER AT THE REQUIRED TAKE-OFF AND APPROACH SPEEDS.

RTOP NO. 721-52-10 TITLE: JET-AUGMENTOR WING RESEARCH AIRCRAFT, C-8A  
ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

#### TECHNICAL SUMMARY

THE C-8A AIRCRAFT WILL BE MODIFIED TO INCORPORATE THE AUGMENTOR-WING HIGH-LIFT CONCEPT AND JET ENGINES TO PROVIDE A PROOF OF THE CONCEPT FOR PROVIDING THE TAKEOFF AND LANDING PERFORMANCE REQUIRED FOR FAN-JET STOL TRANSPORT AIRCRAFT, AND TO MAKE AVAILABLE AN AIRCRAFT FOR CARRYING OUT LONG RANGE FLIGHT RESEARCH ON THE JET STOL TYPE OF AIRCRAFT. THE MODIFIED AIRCRAFT IS EXPECTED TO HAVE THE CAPABILITY OF LANDING AND TAKEOFF AT SPEEDS OF 65 TO 70 KNOTS REQUIRED FOR A STOL BALANCED FIELD LENGTH OF 1500 FEET. THE AIRCRAFT WILL HAVE THE PERFORMANCE AND CONTROL CHARACTERISTICS REQUIRED TO ALLOW FLIGHT INVESTIGATIONS OF TAKEOFF AND LANDING APPROACH PROFILES AND PROCEDURES FOR MINIMIZING NOISE OR TIME. THE PROGRAM IS A COOPERATIVE EFFORT BY NASA AND THE CANADIAN GOVERNMENT THAT HAS BEEN UNDERWAY SINCE 1965. THE PROGRAM ENCOMPASSES ANALYTICAL STUDIES, WIND-TUNNEL INVESTIGATIONS GROUND-BASED SIMULATION STUDIES, DESIGN FEASIBILITIES STUDIES, DETAIL DESIGN AND MODIFICATION OF AIRCRAFT, AND FLIGHT INVESTIGATIONS. THE PROGRAM WILL PROVIDE MUCH NEEDED INFORMATION FOR THE DESIGNERS OF FAN-JET STOL AIRCRAFT WHICH THE NASA SHORT-HAUL V/STOL TRANSPORT STUDIES SHOWED TO BE ONE OF TWO V/STOL CONCEPTS THAT HAD THE LOWEST DIRECT OPERATING COSTS FOR 500-MILE RANGE COMMERCIAL TRANSPORTS.

RTOP NO. 721-54-10 TITLE: DORNIER DO-31 FLIGHT TESTS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-941-1111  
TECHNICAL SUMMARY

A PROGRAM FOR FLIGHT STUDIES OF THE DO-31 VTOL TRANSPORT AIRPLANE AND A PILOTED SIMULATION OF THE DO-31, BEING CONDUCTED ON THE 6-DEGREE-OF-FREEDOM MOTION SIMULATOR, ARE BEING CONDUCTED TO ESTABLISH THE TERMINAL AREA PERFORMANCE ENVELOPE OF THE AIRCRAFT AS LIMITED BY AERODYNAMIC CHARACTERISTICS, STABILITY AND CONTROL CONSIDERATIONS, HUMAN FACTORS, PROPULSION SYSTEM LIMITATIONS, ETC. THIS WILL PROVIDE A GOOD UNDERSTANDING OF THE DO-31'S PECULIAR CHARACTERISTICS AS WELL AS ITS CHARACTERISTICS WHICH APPLY TO THE GENERAL CASE OF LARGE VTOL AIRCRAFT IN TERMINAL AREA SITUATIONS.

RTOP NO. 721-54-10 TITLE: DORNIER DO-31 FLIGHT TESTS  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

FLIGHT STUDIES WILL BE CARRIED OUT BY LANGLEY AND AMES PERSONNEL ON THE DO-31 JET VTOL TRANSPORT IN FRG IN A COOPERATIVE NASA-DORNIER-FRG PROGRAM. THE OBJECTIVES ARE TO DEFINE THE FLIGHT CONTROL SYSTEMS REQUIREMENT AND THE REQUIRED FLIGHT TECHNIQUES AND PROCEDURES FOR A LARGE JET V/STOL AIRCRAFT HAVING A MIXED LIFT PLUS LIFT-CRUISE PROPULSION SYSTEM DURING THE CRITICAL TERMINAL AREA APPROACH AND LANDING IN INSTRUMENT WEATHER. PILOT MANAGEMENT OF THE MIXED PROPULSION SYSTEM, THE AIRCRAFT AERODYNAMIC CHARACTERISTICS AND FLIGHT PATH CONTROL, THE RESPONSE TO ATMOSPHERIC DISTURBANCES AND THE TIME AND FUEL CONSUMED IN APPROACH ARE UNKNOWN AREAS FOR RESEARCH FOR THIS PARTICULAR TYPE OF AIRCRAFT.

RTOP NO. 721-55-10 TITLE: TILT ROTOR RESEARCH AIRCRAFT  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

THE PROGRAM IS A JOINT NASA/ARMY/AIR FORCE EFFORT AND IS DIRECTED TOWARD THE ADVANCEMENT OF TECHNOLOGY OF THE TILT-ROTOR AIRCRAFT CONCEPT TO THE POINT WHERE THE DESIGN OF MEDIUM WEIGHT COMMERCIAL OR MILITARY TRANSPORTS EMPLOYING THE TILT-ROTOR CONCEPT CAN BE UNDERTAKEN WITH CONFIDENCE. TO THIS END, PRELIMINARY DESIGN STUDIES AND WIND-TUNNEL INVESTIGATIONS ARE BEING UNDERTAKEN THAT WILL CUMINATE IN THE DESIGN, FABRICATION, AND FLIGHT INVESTIGATIONS OF A TILT-ROTOR RESEARCH AIRCRAFT. THE PROGRAM WILL ENCOMPASS BOTH THE TILT-ROTOR AND TILT-FOLD-ROTOR CONCEPTS. WIND-TUNNEL INVESTIGATIONS WILL BE MADE OF LARGE-SCALE ROTORS AND OF SMALL-SCALE, FULL-SPAN, AND SEMISPAN MODELS. THE RESEARCH AIRCRAFT WILL BE USED TO INVESTIGATE (1) THE EFFECTS OF MANEUVERING AND DYNAMIC FLIGHT CONDITIONS ON THE COUPLED ROTOR-PYLON-WING STABILITY AND DYNAMIC CHARACTERISTICS ON THE FEASIBILITY OF THE ROTOR FOLDING SEQUENCES, PARTICULARLY IN GUSTY AIR, AND THE TIME REQUIRREMENTS, AND PILOT WORK LOAD, (2) STEEP-GRADIENT TAKE-OFFS AND LANDING APPROACHES IN TERMS OF PILOT



WORK LOAD, TIME AND FUEL REQUIRED AND NOISE LEVELS, AND (3) MILITARY-RELATED PROBLEMS ASSOCIATED WITH LOW-SPEED MANEUVERABILITY. THE TILT-ROTOR CONCEPT IS OF INTEREST FOR BOTH COMMERCIAL AND MILITARY APPLICATIONS BECAUSE IT APPEARS TO OFFER A GOOD COMPROMISE BETWEEN SATISFACTORY HOVERING PERFORMANCE AND A GOOD CRUISE EFFICIENCY. IT IS ALSO OF INTEREST FOR MILITARY TRANSPORT AND RESCUE MISSIONS BECAUSE OF THE LOW DOWNWASH VELOCITIES AND TEMPERATURES ASSOCIATED WITH LOW-DISC LEADING TILT ROTORS.

RTOP NO. 721-56-10 TITLE: ADVANCED LIFT FANS, XV-5B  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

THE XV-5B AIRCRAFT WILL BE MODIFIED TO INCORPORATE ADVANCED QUIET LIFT FANS, GAS GENERATORS, AND CONTROL SYSTEMS TO PROVIDE A RESEARCH VEHICLE FOR DEVELOPING A FIRM TECHNOLOGICAL BASE FOR THE DESIGN OF LARGE LIFT-FAN V/STOL TRANSPORT AIRCRAFT. THE RESEARCH AIRCRAFT WILL BE USED IN A PROGRAM TO EXAMINE THE TAKE-OFF AND LANDING APPROACH CHARACTERISTICS OF THE LIFT-FAN TYPE OF VTOL AIRCRAFT, AND THE ACCOMPANYING HANDLING QUALITIES AND NOISE CHARACTERISTICS. IN PARTICULAR, INVESTIGATIONS WILL BE MADE OF TAKE-OFF AND LANDING APPROACH PROFILES AND PROCEDURES UNDER BOTH VFR AND IFR CONDITIONS THAT WILL ALLOW SHORT TIME PERIODS, MINIMUM NOISE LEVELS, AND OPERATION IN UNUSED AIR AND GROUND SPACE AT MAJOR TERMINAL AREAS. THE ADVANCED QUIET LIFT FANS WILL OPERATE AT A PRESSURE RATIO OF ABOUT 1.4, AND WILL PROVIDE HIGHER THRUST-TO-WEIGHT, AND THRUST-TO-VOLUME RATIOS, AND LOW SIDELINE NOISE LEVELS THAN THE PRESENT XV-5B FANS. THE MODIFICATIONS TO THE CONTROL SYSTEM WILL PROVIDE INCREASED CONTROL EFFECTIVENESS AND IMPROVED THRUST VECTORING CAPABILITY WITH LESS POWER REQUIRED FROM THE GAS GENERATORS. THE LIFT-FAN V/STOL TRANSPORT APPEARS TO BE ONE OF THE MOST PROMISING CONCEPTS FOR MEETING THE NATION'S CIVIL-MILITARY TRANSPORTATION NEEDS. THIS TYPE OF AIRCRAFT WILL PERMIT STEEP-GRADIENT TAKE-OFF AND LANDING APPROACH PROFILES THAT ARE REQUIRED TO MINIMIZE AIR AND GROUND SPACE, AND NEAR-TERMINAL NOISE LEVELS, AND WITH MINIMUM COMPROMISE OF THE HIGH----

RTOP NO. 722-01-10 TITLE: AERODYNAMIC CHARACTERISTICS OF HYPERSONIC AIRCRAFT CONFIGURATIONS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

BECAUSE HYPERSONIC AIRCRAFT WILL ENCOUNTER NEW OR MAGNIFIED PROBLEMS, IN COMPARISON WITH LOWER SPEED AIRCRAFT IT IS ALREADY CERTAIN THAT THE SHAPE OF THESE VEHICLES WILL BE DIFFERENT. CONSEQUENTLY, AMES HAS UNDERTAKEN A BASIC RESEARCH INVESTIGATION TO DETERMINE, ANALYTICALLY AND EXPERIMENTALLY, FEASIBLE AND PRACTICABLE

## CONFIGURATIONS FOR HYPERSONIC AIRPLANES.

RTOP NO. 722-01-10 TITLE: CONFIGURATION STUDIES  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE PURPOSE OF THIS WORK IS TO PROVIDE THE TECHNOLOGY FOR THE DESIGN OF EFFICIENT, PRACTICAL HYPERSONIC AIRBREATHING AIRCRAFT. A NUMBER OF AIRCRAFT SYSTEMS ARE BEING STUDIED. THESE INCLUDE HYPERSONIC TRANSPORTS, MILITARY STRIKE AND RECONNAISSANCE VEHICLES, HYPERSONIC RESEARCH AIRPLANES, AND THE AIRBREATHING LAUNCH VEHICLE. THE AIRBREATHING LAUNCH VEHICLE WHICH IS CAPABLE OF PROVIDING A TRULY LOW-COST SPACE LOGISTICS SYSTEM CAN FILL AN EXPECTED NEED IN THE NASA/DOD PROGRAM IN THE 1985-1995 TIME PERIOD. IT WILL, THEREFORE, BE THE PRIMARY SYSTEM CONSIDERED. MOST OF THE TECHNOLOGICAL ADVANCES NEEDED FOR THIS SYSTEM WILL HAVE DIRECT APPLICATION TO OTHER HYPERSONIC AIRCRAFT. ANY AIRBREATHING LAUNCH VEHICLE SYSTEM INTENDED TO REPLACE THE ILRV DEVELOPED IN THE 1970'S, MUST FULLY EXPLOIT THE INTERACTIONS BETWEEN AERODYNAMICS, PROPULSION, STRUCTURES, TRAJECTORY SELECTION, ETC., TO ACHIEVE MAXIMUM OVERALL EFFICIENCY AND OPERATIONAL FLEXIBILITY. DETAILED WORK ON CONFIGURATION CONCEPTS, RELIABLE PREDICTION TECHNIQUES, FULL-SCALE REYNOLDS NUMBER EFFECTS, ENGINE-AIRFRAME INTEGRATION, ETC., WILL BE VIGOROUSLY PURSUED TO PROVIDE THE TECHNOLOGICAL BASE NECESSARY FOR DESIGNING AN AIRBREATHING LAUNCH SYSTEM TO MEET THESE REQUIREMENTS.

RTOP NO. 722-01-10 TITLE: HYPERSONIC RESEARCH AIRPLANE CONCEPT  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: GIBBONS, J. T. TEL. 805-258-3311  
TECHNICAL SUMMARY

HYPERSONIC AIRCRAFT WITH AIRBREATHING PROPULSION SYSTEMS ARE POTENTIALLY ATTRACTIVE; HOWEVER, A FIRM HYPERSONIC AIRCRAFT TECHNOLOGICAL BASE MUST BE DEVELOPED PRIOR TO THE ACTUAL DESIGN AND DEVELOPMENT OF OPERATIONAL AIRCRAFT. A COMPREHENSIVE FLIGHT RESEARCH PROGRAM CAN AND SHOULD PLAY AN IMPORTANT ROLE IN DEVELOPING THIS REQUIRED TECHNOLOGY BASE. THE PRIMARY PURPOSE OF THE WORK PROPOSED HEREIN IS TO PROVIDE A CONTINUING ACTIVITY WHICH WILL PLACE THE FLIGHT RESEARCH CENTER IN A POSITION AT ALL TIMES TO TECHNICALLY SUPPORT THE DEFINITION, DEVELOPMENT, PROGRAM PLANNING, AND FLIGHT TEST OF ANY FUTURE HYPERSONIC RESEARCH AIRPLANE (HRA) PROGRAM. THIS TASK WILL INVOLVE: (A) STUDIES OF THE DEFICIENCIES IN HYPERSONIC AIRCRAFT TECHNOLOGY; (B) IDENTIFICATION OF SPECIFIC FLIGHT RESEARCH REQUIREMENTS; AND (C) THE ESTABLISHMENT OF GUIDELINES FOR CANDIDATE HRA CONCEPTS. ANALYTICAL STUDIES WILL BE PERFORMED IN-HOUSE TO DEFINE PRACTICAL HRA CONCEPTS AND ESTIMATES WILL BE MADE TO DEFINE TYPICAL HRA OPERATIONAL REQUIREMENTS, DEVELOPMENT SCHEDULES, PERFORMANCE, AND RESEARCH CAPABILITIES. CONTRACT STUDIES WILL BE USED TO PROVIDE SUFFICIENT DEPTH TO SPECIFIC AREAS RELATED TO THE DESIGN, DEVELOPMENT, AND QUALIFICATION OF HRA ENGINE AND AIRFRAME HARDWARE.

RTOP NO. 722-02-10 TITLE: STRUCTURES  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

RESEARCH AND DEVELOPMENT IS BEING CARRIED OUT TO ESTABLISH A TECHNOLOGY BASE FROM WHICH THE STRUCTURES FOR HYPERSONIC VEHICLES CAN BE DESIGNED AND EVALUATED. INCLUDED IN THE PROGRAM ARE BOTH ANALYTIC AND EXPERIMENTAL EFFORTS FOR THE DEVELOPMENT OF CONCEPTS FOR THERMAL PROTECTION OF LIQUID HYDROGEN TANKS, FUSELAGE STRUCTURES, WING STRUCTURES, AND PROPULSION STRUCTURES. RESEARCH DATA OBTAINED IN THE EXPERIMENTAL PROGRAM WILL SERVE TO EVALUATE DESIGN METHODS AND PROCEDURES AND TO ESTABLISH DESIGN APPLICATION GUIDELINES.

RTOP NO. 722-02-10 TITLE: STRUCTURES  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: VANO, A. E. TEL. 805-258-3311  
TECHNICAL SUMMARY

THE PROGRAM WILL ATTEMPT TO EXPERIMENTALLY VALIDATE SIGNIFICANT HYPERSONIC-VEHICLE STRUCTURAL CONCEPTS AND INVESTIGATE FLIGHT-LOADS MEASURING TECHNIQUES FOR THESE STRUCTURAL CONCEPTS AS THEY APPLY TO THE MHTV.

RTOP NO. 722-03-10 TITLE: HYPERSONIC PROPULSION  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: LEZBERG, E. A. TEL.  
TECHNICAL SUMMARY

EXPERIMENTAL AND ANALYTICAL RESEARCH PROGRAMS WILL BE CONDUCTED ON THE TECHNOLOGY OF HYPERSONIC AIRBREATHING PROPULSION ENGINES. THE PRIMARY EMPHASIS OF THE EXPERIMENTAL WORK WILL BE ON SUPERSONIC COMBUSTION RAMJETS BURNING HYDROGEN FUEL AND THE ASSOCIATED AEROTHERMODYNAMIC PROCESSES, ENGINE COMPONENTS AND ADVANCED FACILITY CONCEPTS. COMPONENT WORK ON HYPERSONIC INLETS WILL BE CONDUCTED WITH THE OBJECTIVE OF INVESTIGATING TWO-DIMENSIONAL FIXED GEOMETRY CONCEPTS WITH EMPHASIS ON SIMULATING COMBUSTOR-INLET INTERACTIONS. HEAT SINK AND WATER COOLED MODELS WILL BE TESTED OVER THE MACH NUMBER RANGE OF 5-7 AT THE PLUM BROOK HPRF. PERFORMANCE RESULTS WILL BE COMPARED WITH EXISTING OR MODIFIED PREDICTION METHODS. COMBUSTION TECHNOLOGY WILL BE DEVELOPED BY: EXPERIMENTS IN SUPERSONIC PENETRATION AND MIXING FOR CONVENTIONAL FUEL INJECTOR DESIGNS AND FOR STRUT INJECTORS UTILIZING VORTEX EFFECTS; STUDIES OF SUPERSONIC DIFFUSION FLAMES TO INVESTIGATE THE EFFECTS OF BURNING ON THE MIXING PROCESS; AND EXPERIMENTS ON IGNITION OF HYDROGEN IN THE TEMPERATURE REGION NEAR 100 DEGREES K WITH VITIATED AIR. LARGE SCALE TESTS OF SUPERSONIC COMBUSTORS WILL BE CONDUCTED IN A VITIATED TEST STREAM TO PROVIDE DESIGN INFORMATION FOR SUPERSONIC COMBUSTION ENGINES FOR A RESEARCH AIRPLANE OR OTHER VEHICLE APPLICATION. TESTS OF COMPLETE COMBUSTORS WITH STRUT AND WALL INJECTION AT SIMULATED MACH 8 TEST CONDITIONS WILL BE CONDUCTED IN AN ALTITUDE FACILITY. ENGINE TESTING OF THE HRE, AEROTHERMODYNAMIC INTEGRATION MODEL WILL BE CONDUCTED AT THE PLUM BROOK HPRF OVER A MACH NUMBER RANGE OF 5-7 TO PROVIDE

INFORMATION ON COMPONENT INTERACTIONS, IGNITION, COMBUSTION MODE TRANSITION AND PERFORMANCE. PILOT-SCALE STUDIES ON THE MIXING AND DECOMPOSITION OF NITRIC OXIDE AND HEATED NITROGEN WILL BE CONTINUED TO ESTABLISH THE PRACTICALITY OF EXTENDING CLEAN AIR TESTING TO MACH 8 OR GREATER WITH CHEMICAL ENERGY ADDITION.

RTOP NO. 722-03-10 TITLE: STUDIES OF THE AIR FLOW IN HYPERSONIC INLETS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

TECHNICAL SUMMARY

FLIGHT AT HYPERSONIC SPEEDS WITH AIRBREATHING PROPULSION SYSTEMS WILL REQUIRE AIR INLETS OF LARGE SIZE AND A HIGH LEVEL OF PERFORMANCE. THE LARGEST SINGLE FACTOR AFFECTING INLET PERFORMANCE WILL BE THE CONDITION, OR STATE OF THE BOUNDARY LAYER ALONG THE INDUCTION PATH UNTIL THE ENGINE FACE IS REACHED. THEREFORE, AMES IS ENGAGED IN SEVERAL STUDIES TO GAIN GREATER INSIGHT INTO THE MECHANISM OF LAMINAR AND TURBULENT BOUNDARY LAYER GROWTH AT HYPERSONIC SPEEDS, AND THE INFLUENCE OF VARIOUS FACTORS KNOWN TO AFFECT THE BOUNDARY LAYER. THE PROBLEMS ARE BEING ATTACKED BY IN-HOUSE AND CONTRACT THEORETICAL STUDIES, AND WIND TUNNEL EXPERIMENTS.

RTOP NO. 722-03-10 TITLE: PROPULSION

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS RTOP ARE TO PROVIDE ADVANCED CONCEPTS OF SCRAMJET ENGINES FOR APPLICATION TO REUSABLE BOOSTERS SUITABLE FOR ORBITAL SHUTTLE SERVICE AND TO MILITARY CRUISE VEHICLES SUCH AS STRIKE - RECONNAISSANCE. BASIC INVESTIGATIONS TO ADVANCE THE TECHNOLOGY FOR THE SCRAMJET ENGINE WILL BE CONDUCTED. CRITERIA FOR ADVANCED DESIGNS INCLUDE: (1) FIXED GEOMETRY INLET (2) SELF-STARTING INLET (3) COOLING REQUIREMENTS SUCH THAT FUEL REQUIRED FOR REGENERATIVE COOLING WILL BE LESS THAN THAT REQUIRED FOR THRUST - REASONABLE SOLUTIONS TO COOLING AND STRUCTURAL PROBLEMS (4) SATISFACTORY PERFORMANCE OVER A MACH NUMBER RANGE FROM 4 TO AS HIGH AS 12 (5) CONFIGURATION WHERE THE ENGINE AND VEHICLE ARE INTEGRATED PRODUCING MAXIMUM OVERALL PERFORMANCE FROM THE COMBINATION. CONCEPTS WITH INTEGRATED INLET-COMBUSTOR DESIGNS ARE UNDER DEVELOPMENT WHICH TAKE FULL ADVANTAGE OF AERODYNAMIC AND THERMODYNAMIC EFFECTS IN OBTAINING THE ABOVE OBJECTIVES. ASYMMETRIC NOZZLE DESIGN CONCEPTS ARE BEING DEVELOPED WHICH PROVIDE PROPER INTEGRATED PERFORMANCE WITH THE VEHICLE. EXPERIMENTAL INVESTIGATIONS OF THE INITIAL COMPONENT DESIGNS AND OF COMBINATIONS OF COMPONENTS WILL BE CONDUCTED IN LANGLEY FACILITIES. SIMULTANEOUSLY WITH ENGINE DESIGN CONCEPT WORK, BASIC TECHNOLOGY IS BEING ESTABLISHED BY INVESTIGATIONS OF FUEL INJECTION AND MIXING, WITH AND WITHOUT REACTION, FOR A WIDE VARIETY OF DESIGN VARIABLES. PILOTED IGNITION FLAME PROPAGATION STUDIES INCLUDING THE DEVELOPMENT OF THEORETICAL MODELS FOR THE MIXING, COMBUSTION, FLOW FIELD DEVELOPMENT, AND KINETIC EFFECTS ARE

CONTINUING; ALSO INVESTIGATIONS OF THE TURBULENT BOUNDARY LAYER DEVELOPMENT WITH HEAT TRANSFER, PRESSURE GRADIENT, AND NON-EQUILIBRIUM EFFECTS OF THE VELOCITY DISTRIBUTION ARE CONDUCTED AND ACCURATE PREDICTION METHODS ARE CONSTRUCTED. HYPERSONIC INLET STARTING INVESTIGATIONS ARE CONDUCTED TO DETERMINE, EXPERIMENTALLY AND ANALYTICALLY, THE EFFECTS OF INGESTING THICK BOUNDARY LAYERS DURING THE STARTING PROCESS, A FLOW CONDITION LIKELY TO BE ENCOUNTERED IN HYPERSONIC VEHICLE-INLET INTEGRATION.

RTOP NO. 722-03-10 TITLE: PROPULSION

ORGANIZATION: HEADQUARTERS

MONITOR: WILBUR, S. W. TEL. 202-962-0183

TECHNICAL SUMMARY

ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS ARE BEING CARRIED OUT TO IMPROVE THE UNDERSTANDING OF THE PROCESSES CONTROLLING COMBUSTION IN SUPERSONIC STREAMS, PARTICULARLY THE INTERRELATIONSHIP OF CHEMICAL KINETICS, HEAT RELEASE, AND JET MIXING, AND TO PROVIDE DESIGN INFORMATION FOR COMBUSTORS BASED ON MEASUREMENTS OF FUEL DISTRIBUTION, TOTAL PRESSURE LOSSES, AND HEAT TRANSFER. FUEL INJECTORS ARE BEING DESIGNED TO PROVIDE RAPID SUBSONIC OR SUPERSONIC MIXING, UNIFORM FUEL-AIR DISTRIBUTION, AND A MINIMUM OF FLOW DISTURBANCES. INJECTOR GEOMETRIES RANGE FROM ORIFICES TO SLOTS THROUGH WHICH THE HYDROGEN FUEL IS INJECTED. JET PENETRATION IS BEING STUDIED FOR VARIOUS INJECTION ANGLES FROM PARALLEL TO ACROSS THE AIRSTREAM AND FOR VARIOUS SPACING. THESE STUDIES ARE CONDUCTED WITH AND WITHOUT CHEMICAL REACTION TO ESTABLISH THE BASIC AERODYNAMICS AND TO ASSESS THE EFFECTS OF IGNITION ON THE MIXING PROCESS.

RTOP NO. 722-52-10 TITLE: HYPERSONIC RESEARCH ENGINE

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

TO DEFINE A PRACTICAL, HIGH-PERFORMANCE, MACH 3 TO 8 LIQUID HYDROGEN HYPERSONIC RAMJET ENGINE OF LABORATORY SIZE BY BUILDING A FULL-SCALE, WATER-COOLED, AEROTHERMODYNAMIC INTEGRATION MODEL (AIM), AND A FULL-SCALE, HYDROGEN-COOLED, STRUCTURES ASSEMBLY MODEL (SAM) OF THE HRE; AND MEASURING THE AEROTHERMODYNAMIC PERFORMANCE FROM MACH 4 TO 8 WITH THE AIM AND EVALUATING AT MACH 7 THE ENGINE STRUCTURES THERMAL PERFORMANCE AND LOW CYCLE FATIGUE CHARACTERISTICS. THE OBJECTIVE IS TO ADVANCE AND CRYSTALLIZE THE TECHNOLOGY OF HYPERSONIC AIRBREATHING PROPULSION SYSTEMS AND EVALUATE THE REQUIREMENTS FOR FUTURE RESEARCH. THE SUPERIOR FUEL ECONOMY OF AIRBREATHING PROPULSION REQUIRES THAT SUCH SYSTEMS BE REEXAMINED IN LIGHT OF THE CURRENT TECHNOLOGY FOR APPLICATION TO ANY NEW HYPERSONIC ATMOSPHERIC FLIGHT MISSION.

RTOP NO. 727-01-01 TITLE: LIFTING BODY FLIGHT RESEARCH PROGRAM  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: MCTIGUE, J. G. TEL. 805-258-3311  
TECHNICAL SUMMARY

THE LOW SUPERSONIC AND SUBSONIC CHARACTERISTICS OF LIFTING REENTRY VEHICLES ARE BEING STUDIED BY MEANS OF A COORDINATED FLIGHT AND WIND TUNNEL TEST PROGRAM WITH M2-F3, HL-10, AND X-24A AIRCRAFT. THE PROGRAM WILL YIELD THE DETAILED AERODYNAMIC CHARACTERISTICS OF THESE AIRCRAFT AND A MEASURE OF THE ABILITY OF THE WIND TUNNELS TO PREDICT THESE CHARACTERISTICS. IN ADDITION, OPERATIONAL CHARACTERISTICS IN THE TERMINAL AREA ARE BEING EXPLORED.

RTOP NO. 730-01-01 TITLE: REENTRY COMMUNICATIONS FLIGHT  
EXPERIMENTSCTS

ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: MCTIGUE, J. G. TEL.

TECHNICAL SUMMARY

THESE EXPERIMENTS ARE DESIGNED TO MEASURE BASIC PARAMETERS AFFECTING COMMUNICATIONS, INCLUDING COMMUNICATION "BLACKOUT," DURING REENTRY AND TO EXAMINE MEANS FOR ALLEVIATING COMMUNICATIONS BLACKOUT.

THE REMAINING EXPERIMENT IN THIS SERIES WILL OBTAIN BASIC PLASMA DATA AND EXAMINE THE EFFECTIVENESS OF ELECTROPHYLIC MATERIALS ADDITIONS AS COMPARED TO WATER ADDITIONS IN ALLEVIATING BLACKOUT.

RTOP NO. 731-11-41 TITLE: HYDROGEN-OXYGEN LAUNCH VEHICLE ENGINE  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: DANKHOFF, W. F. TEL. 216-433-4000  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM HAS BEEN TO CONDUCT RESEARCH AND TECHNOLOGY DIRECTED AT REDUCING COSTS, IMPROVING RELIABILITY AND INCREASING THE OPERATIONAL CAPABILITY OF CRITICAL COMPONENTS OF HYDROGEN-OXYGEN LAUNCH VEHICLE ENGINES. HOWEVER, IN VIEW OF PRESSING DEMANDS FOR PERSONNEL IN OTHER AREAS, THIS ACTIVITY WILL BE PHASED OUT IN F.Y. 1970.

RTOP NO. 731-11-43 TITLE: SHUTTLE AIRBREATHING ENGINE TECHNOLOGY  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: STEWART, W. L. TEL. 216-433-4000  
TECHNICAL SUMMARY

A CRITICAL ASPECT OF THE SHUTTLE MISSION, BASED UPON CURRENT REQUIREMENTS, IS THE LANDING PHASE FOR BOTH THE BOOSTER AND ORBITER VEHICLES. THIS PHASE OF THE MISSION WILL REQUIRE AIRBREATHING GAS



TURBINE ENGINES EITHER OF THE JET OR FAN TYPE. THE EFFORTS TO BE MADE IN CONJUNCTION WITH THESE ENGINE PROGRAMS INCLUDES (A) STUDIES, USING EXISTING CANDIDATE ENGINES AS A BASIS, OF CHANGES IN STRUCTURE, MATERIALS, ETC. THAT MUST BE MADE TO PERMIT THESE ENGINES TO MEET THE NEW REQUIREMENTS IMPOSED BY THE SHUTTLE MISSION (LAUNCH, SPACE ENVIRONMENT, REENTRY, ETC.) (B) THE INVESTIGATION OF PROBLEMS IN ADAPTING THESE ENGINES TO THE USE OF H<sub>2</sub> AS THE FUEL (INCLUDES COMBUSTOR MODIFICATIONS, ALTITUDE STARTING, ENGINE CONTROLS, PUMPING SYSTEMS, ETC.), (C) INVESTIGATION OF PROBLEMS ASSOCIATED WITH EXISTING OR NEW HIGH THRUST-TO-WEIGHT ENGINES FOR THE ORBITER WHERE WEIGHT IS MOST CRITICAL, AND (D) UPON FINAL SELECTION OF THE BOOSTER AND ORBITER ENGINES, THE MODIFICATION AND INVESTIGATION OF ONE OF EACH ENGINE AT A PACE SUCH THAT THE ENGINES SERVE AS PROTOTYPE VERSIONS.

RTOP NO. 731-11-44 TITLE: LUBRICATION, BEARINGS AND SEALS  
TECHNOLOGY FOR SHUTTLE BOOSTER AND  
ORBITING VEHICLES

ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: ANDERSON, W. J. TEL.  
TECHNICAL SUMMARY

MATERIALS AND LUBRICANTS SELECTION, DEVELOPMENT, DESIGN THEORY ANALYSIS AND EXPERIMENTATION WILL BE PERFORMED UNDER EXTREME CONDITIONS ASSOCIATED WITH VEHICLE COMPONENTS SUBJECT TO LUBRICATION, FRICTION, WEAR AND HYDRAULICS PROBLEMS. COMPONENTS MUST FUNCTION AFTER EXPOSURE TO VACUUM, AIR AT EXTREME TEMPERATURES WITH MINIMUM WEIGHT. VEHICLE FRAME CONTROL AND MOUNTING SURFACES SUBJECT TO FAYING AND FRETTING, CONTROL BEARINGS, WING PIVOT BEARINGS, BRAKES, AND ACTUATION SYSTEMS FOR FLIGHT CONTROL SURFACES. MINIMUM WEIGHT, EFFICIENCY AND EXTENDED LIFE ARE ESSENTIAL.

RTOP NO. 731-11-45 TITLE: BEARING AND LUBRICATION TECHNOLOGY FOR  
SHUTTLE BOOSTER AND ORBITING VEHICLE  
ENGINES

ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: ANDERSON, W. J. TEL.  
TECHNICAL SUMMARY

FOR THE HYDROGEN-OXYGEN ENGINE, LONGER LIFE SELF-LUBRICATING ROLLING BEARING CAGE AND SEAL MATERIALS, AND LUBRICATION TECHNIQUES WILL BE DEVELOPED FOR OPERATION IN BOTH FLUIDS. MATERIAL STUDIES WILL INCLUDE SOLID LUBRICANTS, SOFT METALLIC FILMS, IMPREGNATED POROUS MATERIALS AND ALLOYS CONTAINING SELF-LUBRICATING CONSTITUENTS. FOR THE HYDROGEN FUELED AIRBREATHING ENGINE, EFFORT WILL BE CONCENTRATED ON THE DEVELOPMENT OF: (1) FLUID AND SOLID LUBRICANTS WITH BETTER HIGH TEMPERATURE CAPABILITY; (2) ROLLING BEARINGS CAPABLE OF LONG LIFE AT 3 TO 4 MILLION DN; AND, (3) SEALS CAPABLE OF LONG LIFE AND SUSTAINED OPERATION AT 700 FEET PER SECOND SLIDING SPEED.

RTOP NO. 731-12-41 TITLE: SPACE STORABLE SYSTEMS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: CONRAD, E. W. TEL. 216-433-4000  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE COMPONENT, SUBSYSTEM, AND SYSTEM DESIGN CRITERIA FOR PROPULSION SYSTEMS USING SPACE STORABLE PROPELLANTS AND TO DEMONSTRATE THE PERFORMANCE AND TECHNOLOGY READINESS OF BOTH A PUMP-FED ENGINE AND A COMPLETE PROPULSION MODULE, FOR SIMULATED MISSION OF 1000 DAYS. APPROACH: THE PROGRAM OBJECTIVES WILL BE MET THROUGH DESIGN, FABRICATION AND DEMONSTRATION TESTING OF A RESEARCH PROPULSION MODULE. APPLICABILITY TO A REAL FLIGHT SYSTEM WILL BE ENSURED BY THE USE OF FLIGHT WEIGHT HARDWARE AND BY CONSIDERATION OF ALL REAL AREAS OF SYSTEM INTERACTION, SPACE ENVIRONMENT, AND LAUNCH VEHICLE AND PAYLOAD CONSTRAINTS AND INTERFACES. THE PROGRAM WILL DEVELOP AND DEMONSTRATE TECHNOLOGY IN FOUR PRIMARY AREAS: (1) INVESTIGATION OF A 5000 POUND THRUST RESEARCH ENGINE USING FLOX-METHANE, (2) DEMONSTRATION OF AN INTEGRATED PROPULSION MODULE SUITABLE FOR DEEP SPACE OPERATION (1000DAYS), (3) DEMONSTRATION OF A COMPLETE FLOX PROPELLANT FEED SYSTEM (INCLUDING PRESSURIZATION) WITH THE REQUIRED STEADY-STATE AND DYNAMIC OPERATING CHARACTERISTICS AND (4) INTEGRATION INTO THE PROPULSION MODULE OF ALL PRIMARY SUBSYSTEMS, SUCH AS AUXILIARY PROPULSION, ATTITUDE CONTROL SYSTEM, THRUST VECTOR CONTROL, ETC. ULTIMATELY, THE COMPLETE MISSION(S) WILL BE DEMONSTRATED IN THE B-2 FACILITY UNDER SIMULATED SPACE CONDITIONS.

RTOP NO. 731-12-42 TITLE: SPACE STORABLE PROPULSION MODULE  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137  
TECHNICAL SUMMARY

THE WORK CONDUCTED UNDER THIS UNIT IS DIRECTED TOWARDS THE DEMONSTRATION OF THE PERFORMANCE AND OPERATIONAL CAPABILITIES OF A SPACE STORABLE PROPULSION MODULE USING OXYGEN DIFLUORIDE AND DIBORANE (OF<sub>2</sub>/B<sub>2</sub>H<sub>6</sub>) AS PROPELLANTS UNDER ENVIRONMENTAL TEST CONDITIONS. BECAUSE OF ITS HIGH PERFORMANCE, THE PROPELLANT COMBINATION OF OF<sub>2</sub>/B<sub>2</sub>H<sub>6</sub> WILL SIGNIFICANTLY INCREASE SPACECRAFT PAYLOADS OVER CURRENTLY USED PROPELLANT COMBINATIONS. A PREPROTOTYPE DEMONSTRATION PROGRAM WILL BE UNDERTAKEN TO GAIN AN UNDERSTANDING AND ACQUIRE A DEPTH OF KNOWLEDGE CONCERNING THE SUBSYSTEM INTERACTIONS OF A PROPULSION SYSTEM USING THE AFOREMENTIONED PROPELLANT COMBINATION. THE DEMONSTRATION SYSTEM WILL INITIALLY USE CURRENTLY AVAILABLE FLIGHT-WEIGHT (BUT SHORT DURATION) COMPONENTS. AS LONG-DURATION, FLIGHTWEIGHT COMPONENTS BECOME AVAILABLE THEY WILL BE SUBSTITUTED FOR THEIR LESS ADEQUATE COUNTERPARTS AND TESTS WILL BE CONDUCTED TO DETERMINE THE EFFECTS OF THE NEW COMPONENTS ON THE SYSTEM. THE PROGRAM WILL CONTINUE THIS APPROACH UNTIL THE METAMORPHOSIS BETWEEN THE PREPROTOTYPE SYSTEM AND THE FLIGHTWORTHY SYSTEM HAS BEEN COMPLETED. THE LONG-DURATION, FLIGHTWEIGHT SYSTEM WILL THEN UNDERGO A MODIFIED PRE-FLIGHT RATING TEST SERIES TO VERIFY THE OPERATIONAL READINESS OF THE OF<sub>2</sub>/B<sub>2</sub>H<sub>6</sub> PROPULSION MODULE FOR SPACECRAFT APPLICATION.

RTOP NO. 731-12-45 TITLE: HYDROGEN-FLUORINE SYSTEMS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: CONRAD, E. W. TEL. 216-433-4000  
TECHNICAL SUMMARY

OBJECTIVE: THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE COMPONENT, SUB-SYSTEM, AND SYSTEM DESIGN CRITERIA FOR SPACE PROPULSION SYSTEMS USING FLUORINE-HYDROGEN PROPELLANTS, AND TO DEMONSTRATE THE PERFORMANCE AND TECHNOLOGY READINESS OF A COMPLETE PROPULSION MODULE FOR SIMULATED MISSIONS OF 1000 DAYS. APPROACH: THE PROGRAM OBJECTIVES WILL BE MET THROUGH ANALYSIS, DESIGN, FABRICATION, AND DEMONSTRATION TEST OF A RESEARCH PROPULSION MODULE. APPLICABILITY TO A REAL FLIGHT SYSTEM WILL BE ENSURED BY THE USE OF FLIGHT-WEIGHT HARDWARE AND BY CONSIDERATION OF ALL REAL AREAS OF SYSTEM INTERACTION, SPACE ENVIRONMENT, AND LAUNCH VEHICLE AND PAYLOAD CONSTRAINTS AND INTERFACES. THE PROGRAM WILL DEVELOP AND DEMONSTRATE TECHNOLOGY IN FOUR PRIMARY AREAS: (1) DEMONSTRATION OF AN INTEGRATED PROPULSION MODULE SUITABLE FOR DEEP-SPACE OPERATION (1000 DAYS), (2) DEMONSTRATION OF A COMPLETE FLUORINE PROPELLANT FEED SYSTEM (INCLUDING PRESSURIZATION) WITH THE REQUIRED STEADY-STATE AND DYNAMIC OPERATING CHARACTERISTICS, (3) DEMONSTRATION OF LONG-TERM THERMAL STORAGE OF BOTH HYDROGEN AND FLUORINE IN A REALISTIC CONFIGURATION WITH ADEQUATE PROVISIONS FOR GROUND HOLD AND BOOST HEATING, AND (4) INTEGRATION INTO THE PROPULSION MODULE OF ALL PRIMARY SUBSYSTEMS, SUCH AS AUXILIARY PROPULSION AND ATTITUDE CONTROL. ULTIMATELY THE COMPLETE MISSION(S) WILL BE DEMONSTRATED IN THE B-2 FACILITY UNDER SIMULATED SPACE CONDITIONS.

RTOP NO. 731-13-41 TITLE: AUXILIARY PROPULSION SYSTEMS  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: GREGORY, J. W. TEL. 216-433-4000  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE COMPONENT DESIGN CRITERIA, SYSTEM DESIGN CRITERIA AND SYSTEMS DEMONSTRATIONS FOR AUXILIARY PROPULSION SYSTEMS USING ADVANCED HIGH ENERGY CRYOGENIC AND SPACE STORABLE PROPELLANTS, SUCH AS HYDROGEN-OXYGEN, HYDROGEN-FLUORINE, AND FLOX-LIGHT HYDROCARBON FUELS. INITIALLY, EFFORTS WILL BE DEVOTED TO DEVELOPMENT OF COMPONENTS, INCLUDING INJECTORS, COOLED THRUST CHAMBERS, HIGH RESPONSE BI-PROPELLANT VALVES, CATALYST BED IGNITORS, PROPELLANT CONDITIONING DEVICES, AND POSITIVE EXPULSION OR OTHER FEED DEVICES. LATER EFFORTS WILL BE APPLIED TO SYSTEM DESIGN, CONTROLS, AND BUILD-UP OF COMPLETE BREADBOARD DEMONSTRATOR SYSTEMS TO EVALUATE SYSTEM INTERACTION AND CONTROL PROBLEMS. THE SYSTEMS WILL BE SIZED FOR POSSIBLE FUTURE INTEGRATION, EVALUATION, AND USE ON RESEARCH PROPULSION MODULES OR OTHER SIMULATED STAGES.

RTOP NO. 731-13-44 TITLE: AUXILIARY PROPULSION SYSTEMS  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: BRIGLIO, A., JR. TEL. 213-354-6137  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS AREA OF WORK IS TO PROVIDE COMPONENTS, SYSTEM DESIGN AND DEMONSTRATION OF LOW THRUST CHEMICAL REACTION MANEUVERING AND ATTITUDE CONTROL SYSTEMS WITH PARTICULAR ATTENTION TO LONG LIFE IN THE SPACE ENVIRONMENT. TO COMPLETE THE PRESENT ON-GOING EFFORT TO DEMONSTRATE THE FUNCTIONAL PERFORMANCE OF WARM GAS ATTITUDE CONTROL SYSTEMS, PROPELLANT STORAGE COMPONENTS WILL BE INTEGRATED WITH THREE TYPES OF WARM GAS GENERATORS (AN AMMONIA VAPORIZATION SYSTEM, A HYDRAZINE PLENUM SYSTEM, AND A HYDRAZINE ELECTROLYSIS CELL) AND TESTED WITH A GAS DISTRIBUTION SUBSYSTEM IN BREADBOARD REACTION CONTROL SYSTEMS. BASED ON THE RESULTS OF THESE DEMONSTRATIONS AS WELL AS MISSION ANALYSES BEING PERFORMED, BREADBOARD SYSTEM SPECIFICATIONS WILL BE GENERATED AND DEMONSTRATIONS PERFORMED, IN ORDER TO PROVIDE ADVANCED SYSTEMS FOR UPCOMING SPACECRAFT PROJECTS. ADDITIONAL COMPONENTS INVESTIGATIONS WILL BE JUSTIFIED ON THE BASIS OF FAVORABLE COMPARISONS WITH EXISTING EXPERIMENTAL HARDWARE IN THE CASE OF NEW CONCEPTS, OR ON THE BASIS OF LOW OR UNRELIABLE PERFORMANCE IN THE DEMONSTRATION PROGRAM. THE INTEGRITY OF MONOPROPELLANT CATALYST BEDS WILL BE IMPROVED AND HYDRAZINE REACTOR VACUUM START CHARACTERISTICS WILL BE DETERMINED. COMPATIBILITY OF CONSTRUCTION MATERIALS FOR LIQUID PROPULSION SYSTEMS WITH PROPELLANTS WILL BE TESTED AND THE IMPLICATIONS OF LONG-TERM SPACE STORAGE WILL BE INVESTIGATED. ADVANCEMENT OF THE STATE-OF-THE-ART OF EXPULSION DEVICES AND LIQUID PROPULSION SYSTEM COMPONENTS WILL BE PURSUED.

RTOP NO. 731-13-45 TITLE: MONOPROPELLANT AUXILIARY PROPULSION  
SYSTEM DEMONSTRATION  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: YETMAN, A. A. TEL. 301-982-5021  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS AREA OF WORK IS TO EVALUATE LOW-THRUST CHEMICAL AUXILIARY PROPULSION SYSTEMS FOR APPLICATION TO SMALL SPACE VEHICLES. THE WORK WILL BE PRIMARILY RELATED TO MONOPROPELLANT HYDRAZINE SYSTEMS. THE EVALUATIONS CAN BE APPLIED TO THE DEVELOPMENT OF SYSTEMS DIRECTLY APPLICABLE TO PRESENT GSFC PROPULSION REQUIREMENTS FOR SPACECRAFT ATTITUDE CONTROL, STATION KEEPING, AND STATION CHANGING AND FOR LAUNCH VEHICLE VERNIER CORRECTION. THE MAJOR PORTION OF THIS WORK WILL BE CONDUCTED IN THE GSFC PROPULSION LABORATORIES AND AT THE GSFC CHEMICAL PROPULSION RESEARCH FACILITY.

RTOP NO. 731-13-46 TITLE: ADVANCED CHEMICAL PROPULSION SYSTEM  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: POHL, H. O. TEL. 713-483-4971  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO CARRY OUT EXPERIMENTAL ENGINEERING EFFORT IN ADVANCED ATTITUDE CONTROL PROPULSION SYSTEM AREAS IN ORDER TO ESTABLISH A TECHNOLOGY BASE FROM WHICH SOUND

ENGINEERING TRADEOFFS CAN BE EFFECTED. HYDRAZINE MONOPROPELLANT SYSTEMS, METHANE/OXYGEN SYSTEMS, AND ONBOARD CHECKOUT/FAILURE DETECTION SYSTEMS WILL BE STUDIED. INTERHALOGEN SYSTEMS WILL BE STUDIED IN SUBSEQUENT YEARS. METHANE/OXYGEN THREESTERS WILL BE STUDIED TO EVALUATE PERFORMANCE, STABILITY, THERMAL BEHAVIOR, KINETICS, IGNITION BEHAVIOUR, AND IGNITION METHODS FOR MULTIPLE RESTART APPLICATIONS.

RTOP NO. 731-13-47 TITLE: EARTH ORBIT LOGISTICS SPACECRAFT-CHEMICAL  
ROCKET EXPERIMENTAL ENGINEERING

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: POHL, H. O. TEL. 713-483-4971

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO CARRY OUT COMPREHENSIVE SYSTEM DESIGN STUDIES OF THE ATTITUDE CONTROL PROPULSION SYSTEM (ACPS) OF THE SPACE SHUTTLE ORBITER AND BOOSTER VEHICLES. THE STUDIES WILL CONSIDER ONLY GASEOUS OXYGEN - GASEOUS HYDROGEN SYSTEMS.

CANDIDATE ACPS CONCEPTS WILL BE SYNTHESIZED AND EVALUATED IN DETAIL TO DETERMINE COMPONENT REQUIREMENTS, COMPLEXITY, SYSTEM WEIGHT AND VOLUME, SYSTEM POWER REQUIREMENTS, SYSTEM PERFORMANCE CHARACTERISTICS, RELATIVE TECHNICAL RISK IN DEVELOPMENT, AND CRITICAL TECHNOLOGY AREAS. THE STUDY RESULTS WILL GUIDE SUBSEQUENT SPACE SHUTTLE AND ACPS DEVELOPMENT EFFORTS, WILL IDENTIFY DEVELOPMENTAL PRIORITIES, AND WILL INSURE THAT ASSIGNED OR IMPLIED ACPS FUNCTIONAL REQUIREMENTS ARE CONSISTENT WITH REALISTICALLY ACHIEVABLE GOALS.

RTOP NO. 731-13-48 TITLE: SPACE SHUTTLE AUXILIARY PROPULSION ENGINES  
ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: NORED, D. L. TEL. 216-433-4000

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO PROVIDE THE REQUIRED BACKGROUND OF TECHNOLOGY FOR THE AUXILIARY PROPULSION ENGINE FOR THE SPACE SHUTTLE. THE MAJOR PORTION OF THIS WORK WILL BE DEVOTED TO ADVANCEMENTS IN THE THRUST CHAMBER ASSEMBLY AREA, INCLUDING THE INJECTOR, THRUST CHAMBER, IGNITION SYSTEM, AND VALVES. THE OPERATING CONDITIONS FOR THE EXPERIMENTAL WORK WILL BE SELECTED TO FIT THE PARTICULAR REQUIREMENTS OF THE SPACE SHUTTLE. THIS WILL INCLUDE OPERATION WITH GASEOUS HYDROGEN/GASEOUS OXYGEN PROPELLANTS IN THE RANGE OF THRUST FROM 750-4000 POUNDS, CHAMBER PRESSURE FROM 20-500 PSIA, AND APPROPRIATE RANGES OF PROPELLANT INLET PRESSURES AND TEMPERATURES. PRIMARY EMPHASIS INITIALLY WILL BE ON THE INJECTOR-CHAMBER COOLING AREA. WHEN THE INDIVIDUAL COMPONENT TECHNOLOGY IS SUFFICIENTLY ADVANCED, (BOTH WITHIN THIS RTOP AND THE COMPLEMENTARY RTOP 128-64 WHICH COVERS IGNITION AND VALVES), POINT DESIGN BREADBOARD THRUST CHAMBER ASSEMBLIES WILL BE FABRICATED AND ASSEMBLED TO PROVIDE AN EVALUATION OF OVERALL PERFORMANCE, RESPONSE AND DURABILITY.

RTOP NO. 731-14-01 TITLE: ATMOSPHERIC DIFFUSION OF TOXIC PROPELLANT  
BY PRODUCTS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: KENIMER, R. L. TEL. 703-827-3661

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS RESEARCH IS TO OBTAIN DATA FOR THE DEVELOPMENT OF DIFFUSION MODELS FOR TOXIC AND/OR RADIOACTIVE MATERIALS. THESE MODELS ARE NECESSARY SO THAT THE QUESTIONS OF HOW, WHEN, AND WHERE SUCH MATERIALS WILL BE TRANSPORTED IN THE ATMOSPHERE AND TO WHAT EXTENT THEY MAY AFFECT PLANT AND ANIMAL LIFE CAN BE ANSWERED. THE OBJECTIVE WILL BE ACCOMPLISHED BY IDENTIFYING THE NECESSARY DIFFUSION MODELS APPLICABLE TO NASA AND DOD MISSILE AND SPACE VEHICLE LAUNCH AREAS. FURTHER, WE WILL ANALYZE SYNOPTIC WEATHER, METEOROLOGICAL TOWER DATA, AND DETAILED WINDS ALOFT DATA TO ESTABLISH NECESSARY PARAMETRIC INPUT DATA TO DIFFUSION EQUATIONS. THE RESULTS OF THIS RESEARCH WILL BE USED IN THE EVALUATION OF TOXIC FUELS RELATIVE TO THE MERITS FOR USE ON THE SPACE SHUTTLE AND OTHER LAUNCH VEHICLE CONFIGURATIONS. EQUALLY IMPORTANT IS THE USE OF THESE DIFFUSION MODELS FOR THE DISPERSION OF AGRICULTURAL AND INDUSTRIAL PRODUCTS.

RTOP NO. 731-25-51 TITLE: LAUNCH VEHICLE SOLID MOTORS

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: CLEPLUCH, C. C. TEL. 216-433-4000

TECHNICAL SUMMARY

THIS PROGRAM ENCOMPASSES THE DEVELOPMENT OF TECHNOLOGY FOR LOW COST AND IMPROVED RELIABILITY IN FUTURE LARGE SOLID MOTOR BOOSTED LAUNCH VEHICLES. THE FY '70 EFFORT WILL CONTINUE INVESTIGATION OF LOW COST AND RELIABLE MATERIALS FOR MOTOR CASES, CASE INSULATION AND NOZZLE HEAT RESISTANT MATERIALS.-----

RTOP NO. 731-25-55 TITLE: SOUNDING ROCKET PROPULSION TECHNOLOGY  
DEVELOPMENT

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: SWAIN, R. L. TEL. 703-827-2888

TECHNICAL SUMMARY

AS A RESULT OF DETAILED STUDIES OF THE REQUIREMENTS FOR ADVANCED PERFORMANCE SOUNDING ROCKETS PERFORMED UNDER CONTRACT AND IN-HOUSE, A NUMBER OF TECHNOLOGY OBJECTIVES HAVE BEEN FORMULATED. THESE OBJECTIVES INCLUDE THE FOLLOWING: (1) DESIGN A SOUNDING ROCKET VEHICLE IN A SINGLE STAGE CONFIGURATION CAPABLE OF PLACING PAYLOADS IN THE ORDER OF 250 LBS TO AN ALTITUDE OF 230 STATUE MILES; (2) PROVIDE A VEHICLE CAPABLE OF USE UNDER AMBIENT ENVIRONMENTAL TEMPERATURES FROM -40 DEGREES F TO 130 DEGREES F WITHOUT SPECIAL CONDITIONING OR EXTENSIVE PROTECTIVE FACILITIES; (3) PERMIT THE USE OF GREATLY SIMPLIFIED LAUNCH AND PREPARATION PROCEDURES; (4) PROVIDE A VEHICLE HAVING GROWTH POTENTIAL TO HIGHER ALTITUDES OR HIGHER PAYLOADS; (5) REDUCE THE OVERALL COST OF PRODUCTION HANDLING AND LAUNCH TO A LEVEL WHICH MAKES POSSIBLE EXPANDED SOUNDING ROCKET OPERATIONS; (6) PERMIT THE EXTENSION OF TECHNOLOGY TO UTILIZE



NON-MAGNETIC CASES AND LOW COST MOLDED NOZZLES; (7) REDUCE THE ACCELERATION LEVELS TO THOSE CONSISTENT WITH SENSITIVE ELECTRONIC AND OPTICAL INSTRUMENTATION AND TO REDUCE THE MAXIMUM DYNAMIC PRESSURE DURING LAUNCH.

RTOP NO. 731-26-52 TITLE: HYBRID PROPULSION ENGINEERING

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: SWAIN, R. L. TEL. 703-827-2888

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROGRAM IS TO ESTABLISH THE REQUIRED ELEMENTS OF TECHNOLOGY OF HIGH ENERGY HYBRID PROPULSION SYSTEMS SUCH THAT A STAGE DEVELOPMENT AND QUALIFICATION PROGRAM COULD BE INITIATED WITH HIGH CONFIDENCE THAT TECHNICAL, COST AND SCHEDULE GOALS COULD BE MET WITHOUT SERIOUS OBSTACLES. CONTRACTED EFFORTS SINCE 1964 HAVE DEMONSTRATED THE TECHNICAL FEASIBILITY AND HIGH POTENTIAL OF HIGH ENERGY HYBRID PROPULSION SYSTEMS FOR UPPER STAGE APPLICATIONS. STUDIES INDICATE THAT THE HYBRID ROCKET WILL PERFORM AS WELL AS COMPETITIVE "SPACE STORABLE" LIQUID SYSTEMS NOW UNDER INVESTIGATION AND THAT THE HYBRID CAN BE DEVELOPED FOR A SIGNIFICANTLY LOWER COST. THE DEMONSTRATION OF HYBRID PROPULSION TECHNOLOGY AT THE FLIGHTWEIGHT PROTOTYPE LEVEL HAS RECENTLY BEGUN AT THE UNITED TECHNOLOGY CENTER, SUNNYVALE, CALIFORNIA. PHASE I OF THIS DEMONSTRATION COVERS THE DESIGN, FABRICATION, AND TESTING OF A FULL-SCALE HEAVYWEIGHT HARDWARE SYSTEM CONTAINING AN ADVANCED HIGH-LITHIUM PROPELLANT, INCLUDING SIMULATED ALTITUDE TESTING.-----

RTOP NO. 731-26-53 TITLE: SOLID HIGH ENERGY SPACE MOTOR

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: WEEKS, P. TEL. 213-354-2546

TECHNICAL SUMMARY

THE OBJECTIVE IS TO ESTABLISH BY FY 1971 THE TECHNOLOGIES AND FUNCTIONS OF A PROTOTYPE SOLID PROPELLANT SPACE PROPULSION SYSTEM, DELIVERING SPECIFIC IMPULSE OF 327 TO 330 SECONDS AT SPACE CONDITIONS, WITH STOP AND RESTART CAPABILITY, ABOUT 8 85,000 POUND-SECONDS IMPULSE, THRUST OF APPROXIMATELY 15,000 POUNDS. THE APPROACH IS TO DEFINE DESIRABLE CHARACTERISTICS OF A HIGH ENERGY SOLID SPACE MOTOR, THROUGH ANALYSIS OF POSSIBLE USES AND COORDINATION WITH POSSIBLE USER ORGANIZATIONS. MAKE NECESSARY PROPELLANT BURNING AND QUALIFICATION TESTS. TEST IN SUBSCALE THE MATERIALS AND FUNCTIONS OF QUENCH SYSTEM. ESTABLISH IMPINGEMENT PATTERN, ORIFICE SEAL DESIGN AND MATERIAL. ESTABLISH BEST STOP-RESTART CYCLE; DESIGN COMPLETE SUBSYSTEM. DESIGN, TEST, EVALUATE A TEST WEIGHT DESIGN, AND THE EFFECTS OF SLAG ACCUMULATION AND CONCENTRATED HEATING. EVALUATE A PROTOTYPE DESIGN AT SPACE CONDITIONS WITH AN ELECTED STOP-RESTART CYCLE. THE UTILIZATION OF THIS MOTOR FUTURE MISSIONS CAN BE COST EFFECTIVE IN COMPARISON TO UTILIZATION OF A LARGER BOOSTER.

RTOP NO. 731-26-54 TITLE: SOLID SPACE PROPULSION  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: WEEKS, P. TEL. 213-354-2546  
TECHNICAL SUMMARY

ESTABLISH THE TECHNOLOGY FOR ADVANCED SOLID SPACE PROPULSION SYSTEM WHICH CAN MEET THE REQUIREMENTS FOR PLANETARY ORBITER SPACECRAFT. THE MAJOR REQUIREMENT IS FOR A LOW-ACCELERATION HIGH-PERFORMANCE PROPULSION SYSTEM. THE CONCEPT UNDERSTUDY IS THE FULLY-CASE-BONDED END-BURNING GRAIN CONFIGURATION WHICH PRODUCES ACCELERATION LEVELS OF LESS THAN 0.5 G. THE FEASIBILITY OF THE CONCEPT HAS BEEN DEMONSTRATED AT JPL IN FY'69. THE FY'70 EFFORT WILL BE LIMITED TO CONTINUATION OF THIS IN-HOUSE WORK TO IMPROVE THE END BURNER PERFORMANCE, TO INVESTIGATE THE EFFECT OF CHANGES IN CONFIGURATION ON PERFORMANCE, AND TO EXPLOIT APPLICATION OF THE END-BURNER----

RTOP NO. 731-27-55 TITLE: FLIGHT RESEARCH EXPLOSIVE SYSTEMS  
ENGINEERING

ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: SWAIN, R. L. TEL. 703-827-2888  
TECHNICAL SUMMARY

THE GOAL OF THIS PROGRAM IS TO PROVIDE FOR THE SAFE AND RELIABLE USE OF ELECTROEXPLOSIVE (PYROTECHNIC) DEVICES IN EXISTING FLIGHT PROGRAMS AND TO PROVIDE THE TECHNOLOGY REQUIRED FOR THE USE OF PYROTECHNIC DEVICES IN ANTICIPATED LONG TERM, SEVERE ENVIRONMENT, FLIGHT PROGRAMS. PYROTECHNIC DEVICES ARE USED TO PERFORM A WIDE VARIETY OF FUNCTIONS SUCH AS IGNITION, SEPARATION, DEPLOYMENT, ETC., IN FLIGHT RESEARCH PROGRAMS AND MISSILE AND AIRCRAFT SYSTEMS. SINCE THE FAILURE OF ANY ONE OF THESE DEVICES COULD RESULT IN A LOSS OF MISSION OBJECTIVES THE NEED FOR HIGH RELIABILITY IS CRITICAL. IN ADDITION INCREASINGLY DEMANDING ENVIRONMENTAL CONDITIONS SUCH AS STERILIZATION HAVE MADE THE TASK OF ACHIEVING THE RELIABILITY EVEN MORE DIFFICULT. THIS PROGRAM IS A CONTINUING EFFORT IN WHICH RESEARCH AND ENGINEERING EVALUATION TESTING OF ELECTROEXPLOSIVE DEVICES WILL BE CONDUCTED UNDER VARIOUS ENVIRONMENTAL CONDITIONS, ANTICIPATED FOR CURRENT AND PROJECTED NASA MISSIONS, TO DETERMINE PERFORMANCE PARAMETERS, FAILURE MODES AND APPLICABILITY FOR FLIGHT RESEARCH USE. THROUGHOUT THE PROGRAM, AN EFFORT WILL BE MADE TO DEVELOP MORE DESCRIPTIVE AND MEANINGFUL TEST PROCEDURES. IN ADDITION SEVERAL ADVANCED IGNITION CONCEPTS WILL BE EVALUATED.

RTOP NO. 731-28-10 TITLE: SOLID TEST METHODS, INSTRUMENTATION AND  
SUPPORT

ORGANIZATION: NASA HEADQUARTERS  
MONITOR: COHEN, W. TEL. 000-962-1807  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO OBTAIN FISCAL AND TECHNICAL INFORMATION NEEDED FOR LONG-RANGE PLANNING OF SOLID PROPULSION PROGRAM; TO ENHANCE THE SAFETY OF MANUFACTURE AND USE OF SOLID MOTORS; TO SUPPORT INTERGOVERNMENT AGENCIES FOR INFORMATION EXCHANGE. STUDY CONTRACTS

OR ASSIGNMENTS ARE ESTABLISHED TO ANALYZE FUTURE PROPULSION REQUIREMENTS AND TO DEFINE MISSIONS IN WHICH FUTURE SOLID (AND HYBRID) SYSTEMS CAN BE USED. COST ANALYSIS IS MADE TO REEVALUATE AND JUSTIFY TECHNOLOGY PROGRAMS LEADING TO THE SYSTEMS FOR MISSION AREAS.

WORK IS SUPPORTED ON HAZARD ANALYSIS AND ON TECHNIQUES TO MINIMIZE HAZARDS OF SOLID PROPULSION SYSTEMS. FUNDS ARE PROVIDED TO CPIA, AN INTERAGENCY INFORMATION CENTER ON CHEMICAL PROPULSION.

RTOP NO. 735-01-01 TITLE: ORBITING FROG OTOLITH PROGRAM

ORGANIZATION: Wallops Station

MONITOR: ROSSI, L. C.

TEL. 703-824-3411

#### TECHNICAL SUMMARY

THE ORBITING FROG OTOLITH PROJECT EXPERIMENT WILL RECORD DIRECTLY THE CHANGES IN ACTIVITY OF THE OTOLITH SYSTEM WHICH MIGHT OCCUR DURING A PERIOD OF PROLONGED WEIGHTLESSNESS. THIS ENVIRONMENTAL CHANGE IS PARTICULARLY SIGNIFICANT BECAUSE THE GRAVITORECEPTORS OF THE VESTIBULAR APPARATUS, THE OTOLITH, ARE SUBJECTED TO A UNIQUE SITUATION IN RESPECT TO THE OTHER SENSE ORGANS.

THEIR DEVELOPMENT TAKES PLACE UNDER A CONSTANT LG STIMULATION WHICH IS PRESENT BEFORE THEY DIFFERENTIATE AND WHICH IS MAINTAINED UP TO THE PRESENT TIME THROUGHOUT THE LIFE SPAN. JET FLIGHT, SPACE FLIGHT, AND POSSIBLE FUTURE MISSIONS ON PLANETS WITH DIFFERENT GRAVITATIONAL CONSTANTS HAVE SUDDENLY CHANGED THIS SITUATION. EXPERIMENT SCIENTISTS WILL BE ABLE TO STUDY FOR THE FIRST TIME HOW THE OTOLITH SENSORS, LONG ADAPTED TO CONSTANT ENVIRONMENTAL STIMULUS, BOTH IN THE INDIVIDUAL AND THE SPECIES AS A WHOLE, REACT TO A RADICAL CHANGE TO A LONG ESTABLISHED HABITUATION INVOLVING THEIR SPECIFIC FUNCTION. THIS WILL BE ACCOMPLISHED BY IMPLANTING MICROELECTRODES IN THE VESTIBULAR NERVES OF TWO BULLFROGS IN ORDER TO MEASURE THE BIOELECTRIC ACTION POTENTIAL PRODUCED BY THEIR OTOLITH DURING WEIGHTLESSNESS AND REPEATED SIMULATED GRAVITY STIMULUS. THE RESULTS WILL PROVIDE A GREAT STEP FORWARD IN UNDERSTANDING THE PHYSIOLOGICAL MECHANISM OF THE OTOLITH AND BY EXTRAPOLATION OTHER SENSE ORGANS. MOREOVER, STIMULUS-RESPONSE RELATIONSHIPS IN THE VESTIBULAR SYSTEM UNDER ZERO GRAVITY CONDITIONS ARE OF PARAMOUNT IMPORTANCE BECAUSE OF THEIR INFLUENCE ON THE VAGUS NERVE SUPPLY RESPONSIBLE FOR MOTION SICKNESS, ON THE VISION SYSTEM, AND ON MUSCULAR TONUS.

RTOP NO. 736-01-10 TITLE: AERODYNAMIC AND STABILITY CHARACTERISTICS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

#### TECHNICAL SUMMARY

THE OBJECTIVE IS TO DEVELOP THE TECHNOLOGY NECESSARY TO EFFECT AN OVERALL IMPROVEMENT IN THE AERODYNAMIC AND STABILITY AND CONTROL

CHARACTERISTICS OF THE GENERAL AVIATION CLASS OF AIRPLANES. THIS WILL BE DONE BY MEANS OF FLIGHT TESTS AND BOTH FULL-SCALE AND SMALL-SCALE WIND-TUNNEL TESTS OF REPRESENTATIVE AIRCRAFT AND OF CONFIGURATION CHANGES DESIGNED TO IMPROVE THESE CHARACTERISTICS.

RTOP NO. 736-04-11 TITLE: FLIGHT SAFETY - GENERAL STUDIES

ORGANIZATION: NASA HEADQUARTERS

MONITOR: ENDERS, J. H. TEL. 202-962-4601

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO CONDUCT A STUDY TO ASSESS THE GENERAL AVIATION ENVIRONMENT OVER THE NEXT DECADE IN TERMS OF TECHNOLOGICAL DESIGN PRACTICE, AND FROM THIS ASSESSMENT TO DEFINE A PROGRAM OF SAFETY RESEARCH FOCUSED UPON THE MOST CRITICAL PROBLEMS FORESEEN. IN PARTICULAR, THE USES TO WHICH THE SMALL AIRPLANE IS BEING PUT ARE MULTIPLYING RAPIDLY AND THEY ARE BEING FLOWN IN SITUATIONS WHERE THERE IS LITTLE PREVIOUS EXPERIENCE WITH THIS CATEGORY AIRCRAFT. THIS IS COMPOUNDED BY THE LOW EXPERIENCE AND LOW PROFICIENCY LEVELS OF MANY OF THE PILOTS AND BY THE STEADILY INCREASING PERFORMANCE LEVELS OF THE AIRCRAFT. THE RESULTS OF THIS STUDY WILL BE USED TO HELP IN RESEARCH PLANNING AND MANAGEMENT OF FUTURE NASA GENERAL AVIATION SAFETY RESEARCH PROGRAMS.

RTOP NO. 736-05-10 TITLE: HANDLING QUALITIES AND FLIGHT CHARACTERISTICS

ORGANIZATION: FLIGHT RESEARCH CENTER

MONITOR: ADKINS, E. J. TEL. 805-258-3311

TECHNICAL SUMMARY

THE BASIC OBJECTIVE OF THE PROGRAM IS TO ACHIEVE SIGNIFICANT IMPROVEMENTS IN THE SAFETY OF FLIGHT AND OVERALL UTILITY OF GENERAL-AVIATION AIRCRAFT. THE APPROACH TAKEN WILL BE THAT OF DEVELOPING IMPROVED HANDLING QUALITIES THAT WILL MAKE THIS CLASS OF AIRPLANE MORE FORGIVING AND THEREBY RELIEVE THE PILOTS CONTROL TASK, PARTICULARLY IN THE ADVERSE WEATHER ENVIRONMENT. THIS PROGRAM WILL RESULT IN THE APPLICATION OF "SPACE AGE" SYSTEM TECHNOLOGY TO GENERAL AVIATION AIRCRAFT. IN ADDITION, IT WILL ADVANCE THE UNDERSTANDING OF THE IMPORTANCE OF HANDLING QUALITIES TO FLIGHT SAFETY AND THEREBY PROVIDE TECHNOLOGY FOR IMPROVED AIRCRAFT CERTIFICATION REGULATIONS.

RTOP NO. 736-05-10 TITLE: HANDLING QUALITIES AND FLIGHT CHARACTERISTICS

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

THE OBJECTIVES ARE (1) TO STUDY FACTORS AFFECTING FLIGHT SAFETY AND, (2) TO IMPROVE THE LEVEL OF SAFETY THROUGH ANALYSIS, WIND TUNNEL STUDIES, AND FLIGHT INVESTIGATIONS OF VARIOUS MEANS FOR SIMPLIFYING THE PILOTING TASK FROM TAKEOFF THROUGH TO LANDING.

RTOP NO. 736-05-10 TITLE: GENERAL AVIATION FLIGHT DYNAMICS  
ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

A FLIGHT INVESTIGATION IS UNDERWAY TO DETERMINE THE FLIGHT CHARACTERISTICS OF AN EXECUTIVE JET AIRCRAFT REPRESENTATIVE OF THOSE JET AIRCRAFT IN THE GENERAL AVIATION FLEET. THE NASA 701 LEAR JET HAS BEEN INSTRUMENTED TO PROVIDE DOCUMENTATION OF BOTH STATIC AND DYNAMIC FLIGHT CHARACTERISTICS. SPECIAL ATTENTION WILL BE DIRECTED TO DETERMINE THE EFFECTS OF TURBULENCE ON THE HANDLING QUALITIES FOR ALL NORMAL FLIGHT REGIMES. ADVANCED FLIGHT DISPLAYS WILL BE STUDIED AS A POTENTIAL FOR SIGNIFICANT REDUCTIONS IN PILOT WORKLOAD. CURRENT, IN-HOUSE STUDIES ARE BEING MADE OF EFFECTS OF TURBULENCE ON THE HANDLING QUALITIES AND PASSENGER RIDE QUALITIES OF REPRESENTATIVE GENERAL AVIATION COMMUTER (THIRD LEVEL CARRIER) AIRCRAFT, COVERING A WIDE RANGE OF AIRCRAFT RESPONSE TO TURBULENCE (E.G., LARGE VARIATIONS IN WING LOADING). A CONTRACT HAS BEEN AWARDED TO AERONAUTICAL RESEARCH ASSOCIATES OF PRINCETON (NAS2-5589) FOR A FLIGHT INVESTIGATION OF SPILER/DIVE BRAKES INSTALLED IN A LIGHT AIRCRAFT TO DETERMINE POTENTIAL IMPROVEMENTS IN GLIDE PATH CONTROL, AND FLARE-TOUCH-DOWN MANEUVERS, AND AS A SAFETY DEVICE TO BE USED IN OVERSPEED CONDITIONS.

RTOP NO. 736-08-10 TITLE: SUMMARY OF RESEARCH APPLICABLE TO GENERAL AVIATION AIRCRAFT

ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

AVAILABLE INFORMATION PERTINENT TO GENERAL AVIATION AIRCRAFT WILL BE ASSEMBLED, REVIEWED AND SUMMARIZED. AN ANALYSIS WILL BE MADE OF RESEARCH RESULTS AVAILABLE FOR PREDICTION OF AIRCRAFT STALLING CHARACTERISTICS, HANDLING QUALITIES, PROPELLER PERFORMANCE, GUST AND MANEUVER LOADS ETC.

RTOP NO. 736-10-10 TITLE: COLLISION AVOIDANCE SYSTEMS  
ORGANIZATION: ELECTRONIC RESEARCH CENTER  
MONITOR: LEIGH, C. H. TEL. 617-494-2409  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS WORK IS TO CARRY OUT FLIGHT TESTS ON AIRCRAFT ANTI-COLLISION SYSTEMS AND PILOT WARNING DEVICES. STUDIES WILL BE FOLLOWED BY DESIGN AND CONSTRUCTION OF PROOF-OF CONCEPT MODELS. OPTIMUM CONFIGURATIONS WILL BE INVESTIGATED AND DEVELOPED THROUGH FLIGHT TESTS AND EXPERIMENTAL DEVELOPMENT. FLIGHT TESTS WILL BE CONDUCTED TO ASSURE THE SYSTEMS OPERATIONAL PERFORMANCES. PRESENT RESEARCH IS DIRECTED TO THE FLIGHT TEST OF INFRARED P. W. I. SYSTEMS AND THE TIME-FREQUENCY SYSTEM APPLICATION TO GENERAL AVIATION AIRCRAFT.

RTOP NO. 737-01-10 TITLE: CONFIGURATION STUDIES  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

TO DETERMINE THE POSSIBLE IMPROVEMENTS IN AERODYNAMIC CHARACTERISTICS, FLYING QUALITIES, AND PERFORMANCE APPLICABLE TO ADVANCED SUBSONIC COMMERCIAL TRANSPORT AIRCRAFT. PARTICULAR ATTENTION WILL BE DIRECTED TO THE COMBINATIONS OF DESIGN FEATURES FOR IMPROVING THE OVERALL LIFT-DRAG RATIO INCLUDING EFFECTS OF ASPECT RATIO, CAMBER, AND TWIST, AS WELL AS THE USE OF FENCES, PYLONS, AND NACELLES IN FAVORABLE ARRANGEMENTS. ALSO TECHNIQUES FOR EXTRAPOLATION OF WIND-TUNNEL TEST DATA TO FULL-SCALE ARE BEING INVESTIGATED.

RTOP NO. 737-01-11 TITLE: AERODYNAMICS OF ADVANCED SUBSONIC TRANSPORTS

ORGANIZATION: AMES RESEARCH CENTER  
MONITOR: ROBINSON, R. G. TEL. 415-961-1111  
TECHNICAL SUMMARY

INVESTIGATIONS ARE BEING CARRIED OUT IN SEVERAL AREAS. CONFIGURATIONS HAVING "T" TAILS AND AFTMOUNTED ENGINES ARE BEING INVESTIGATED FOR STABILITY AND CONTROL CHARACTERISTICS, PARTICULARLY AT ANGLES OF ATTACK BEYOND THOSE FOR MAXIMUM LIFT TO DETERMINE STALL BEHAVIOR AND CONTROL EFFECTIVENESS. BECAUSE REYNOLDS NUMBER EFFECTS ARE IMPORTANT, THE INVESTIGATION IS BY MEANS OF A LARGE-SCALE MODEL IN THE 40- BY 80-FOOT WIND TUNNEL OR IN THE 12-FOOT PRESSURE WIND TUNNEL. CONFIGURATIONS REPRESENTATIVE OF TWO- AND THREE-ENGINE AIRBUS DESIGNS ARE BEING INVESTIGATED TO ASSESS INTERACTIONS BETWEEN ENGINE EXHAUST AND THE AIRFRAME, AND THRUST REVERSE DESIGN CRITERIA, PARTICULARLY RELATIVE TO AN ENGINE MOUNTED IN THE VERTICAL TAIL IN WHICH RUDDER CONTROL DURING REVERSE THRUST MAY BE CRITICAL. THE INVESTIGATIONS ARE MADE USING THE 40- BY 80-FOOT WIND TUNNEL FOR LOW-SPEED CHARACTERISTICS AND THE 12-FOOT PRESSURE WIND TUNNEL FOR CHARACTERISTICS AT HIGH-SUBSONIC SPEEDS.

RTOP NO. 737-02-10 TITLE: SUBSONIC AIRCRAFT FLUTTER AND AEROELASTICITY

ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

THE DEVELOPMENT OF NEW AIRCRAFT TO PROVIDE IMPROVED EFFICIENCY OR TO ACCOMPLISH NEW MISSIONS GENERALLY INVOLVES INCORPORATION OF NEW CONFIGURATION FEATURES. THE RESEARCH TO BE ACCOMPLISHED UNDER THIS RTOP IS INTENDED TO PROVIDE THE KNOWLEDGE NECESSARY TO HANDLE THE FLUTTER AND OTHER AEROELASTIC ASPECTS CONCERNED WITH INCORPORATION OF THESE NEW FEATURES. THIS INFORMATION WILL MAKE IT POSSIBLE TO SAFELY AND EFFICIENTLY APPLY NEW CONFIGURATION CONCEPTS TO NEW AIRCRAFT. GENERALLY, THE WORK WILL INVOLVE EXPERIMENTAL EXAMINATION OF THESE NEW CONFIGURATION FEATURES AS APPLIED TO NEW AIRCRAFT DESIGNS AND THEORETICAL METHODS WILL BE DEVELOPED TO AID IN THE INTERPRETATION



AND APPLICATION OF SUCH NEW CONFIGURATION FEATURES.

RTOP NO. 737-05-10 TITLE: SUBSONIC AIRCRAFT FLIGHT DYNAMICS

ORGANIZATION: AMES RESEARCH CENTER

MONITOR: ROBINSON, R. G. TEL. 415-961-1111

TECHNICAL SUMMARY

INITIAL STAGES OF PREPARATION ARE UNDERWAY ON COOPERATIVE RESEARCH WITH THE FAA ON SIMULATION STUDIES DIRECTED AT ARRIVING AT MORE RATIONAL CRITERIA AND FLIGHT MANEUVERS FOR THE CERTIFICATION OF SUBSONIC TRANSPORTS. THE SIMULATION WILL BE CARRIED OUT USING THE FLIGHT SIMULATOR FOR ADVANCED AIRCRAFT WHICH HAS SOPHISTICATED MOTION AND VISUAL SIMULATION CAPABILITY. INITIAL STUDIES ARE DIRECTED AT STUDYING CERTIFICATION MANEUVERS USING THE BOEING 747 CHARACTERISTICS. ADDITIONAL STUDIES ARE BEING CONSIDERED TO IMPROVE ACCEPTANCE OF THE STEEP APPROACH AS A NOISE ABATEMENT LANDING APPROACH MANEUVER USING THE BOEING 367-80 AIRPLANE AS MODIFIED WITH IMPROVED FLIGHT DIRECTOR GUIDANCE AND DIRECT LIFT CONTROL. STUDIES OF DIRECT LIFT CONTROL ARE PLANNED USING THE F-100C VARIABLE-STABILITY AIRCRAFT TO ASSESS POTENTIAL IMPROVEMENTS IN THE ACCURACY OF WEAPONS DELIVERY. THIS POTENTIAL IS SUGGESTED BY SUCCESSFUL DEMONSTRATION WITH THE F-100C THAT IMPROVEMENTS COULD BE MADE IN PILOT TRACKING PERFORMANCE DURING INFIGHT REFUELING WHEN USING DIRECT LIFT CONTROL.

RTOP NO. 737-51-10 TITLE: STUDY AND DEVELOPMENT OF ACOUSTIC TREATMENT FOR JET ENGINE TAILPIPES

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285

TECHNICAL SUMMARY

PROBLEM - TO DEVELOP ACOUSTIC TREATMENT DESIGNS FOR REDUCING THE TURBINE NOISE AND TURBULENCE GENERATED NOISE RADIATED FROM A JET ENGINE TAILPIPE. APPLICATION - ALTHOUGH THE ACOUSTIC TREATMENT WILL BE TAILORED TO A SPECIFIC ENGINE, THE DESIGN CRITERIA WILL BE PRESENTED IN GENERAL TERMS SO THAT IT CAN BE APPLIED TO CURRENT AND FUTURE TECHNOLOGY COMMERCIAL FANJET ENGINES. APPROACH - CONTRACT FOR THE DESIGN AND DEVELOPMENT OF AN ACOUSTICALLY TREATED TAILPIPE FOR GROUND TESTS ON A JT3D ENGINE. CONDUCT NOISE MEASUREMENTS AND ENGINE PERFORMANCE ANALYSIS.

RTOP NO. 737-52-10 TITLE: EXPERIMENTAL QUIET ENGINE

ORGANIZATION: LEWIS RESEARCH CENTER

MONITOR: KRAMER, J. J. TEL. 216-433-4000

TECHNICAL SUMMARY

PRELIMINARY DESIGN STUDIES AND LEWIS IN-HOUSE RESEARCH HAVE INDICATED THAT A SUBSTANTIAL REDUCTION IN NOISE OUTPUT OF ENGINES SUITABLE FOR SUBSONIC TRANSPORT AIRCRAFT CAN BE ACHIEVED. THE NEXT STEP IN THIS PROGRAM IS TO DEMONSTRATE THIS TECHNOLOGY IN AN EXPERIMENTAL ENGINE. CONTRACT PROGRAMS WILL PROVIDE ENGINE DETAILED

DESIGNS AND FABRICATION, TESTING AND DELIVERY OF TEST ENGINES TO LEWIS RESEARCH CENTER. SUBSEQUENT TESTS OF THESE ENGINES AT LEWIS WITH ACOUSTICALLY TREATED NACELLES WILL DEMONSTRATE MINIMUM INSTALLED PROPULSION SYSTEM NOISE LEVELS.

RTOP NO. 737-52-11 TITLE: QUIET ENGINE RESEARCH  
ORGANIZATION: LEWIS RESEARCH CENTER  
MONITOR: KRAMER, J. J. TEL. 216-433-4000  
TECHNICAL SUMMARY

RESEARCH WILL BE PERFORMED IN VARIOUS AREAS IN DIRECT SUPPORT OF THE QUIET ENGINE. PRIME AREAS OF ACTIVITY ARE FULL-SCALE FAN NOISE TESTING AND FULL-SCALE SUPPRESSOR DEVELOPMENT. THE WORK IN THIS PROGRAM IS IN DIRECT SUPPORT OF RTOP 737-52-10 (EXPERIMENTAL QUIET ENGINE). IN THIS PROGRAM VARIOUS PROBLEM AREAS WILL BE EXPLORED USING HARDWARE OF APPROPRIATE SCALE FOR USE IN THE QUIET ENGINE. INITIAL ACTIVITY WILL CONSIST OF TESTING FULL-SCALE FANS AND SUPPRESSORS DESIGNED FOR USE IN THE QUIET ENGINE. SUBSEQUENT POTENTIAL WORK AREAS ARE SUPPRESSORS FOR FURTHER NOISE REDUCTION OF LOW-VELOCITY JET EXHAUSTS AND INLET CHOKING DEVICES TO REDUCE FAN INLET RADIATED NOISE.

RTOP NO. 737-54-10 TITLE: SUPERCRITICAL WING PROGRAM - WIND TUNNEL  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: LOFTIN, L. K., JR. TEL. 703-827-3285  
TECHNICAL SUMMARY

TO DETERMINE THE FEASIBILITY OF APPLYING THE SUPERCRITICAL WING CONCEPT TO AIRPLANE CONFIGURATIONS. PARTICULAR ATTENTION WILL BE DIRECTED TO THE INTEGRATION OF THE WING WITH THE FUSELAGE, THE APPLICATION OF AERODYNAMIC CONTROL SURFACES, THE DEVELOPMENT OF LOW SPEED HIGH LIFT DEVICES, AND TO THE PREDICTION OF THE FULLSCALE AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE WITH A SUPERCRITICAL WING. BOTH MILITARY AIRCRAFT AND COMMERCIAL TRANSPORT AIRCRAFT APPLICATIONS ARE TO BE INVESTIGATED.

RTOP NO. 737-54-11 TITLE: F-8 SUPERCRITICAL WING INVESTIGATION  
ORGANIZATION: FLIGHT RESEARCH CENTER  
MONITOR: MCTIGUE, J. G. TEL. 805-258-3311  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS EFFORT ARE TO EVALUATE AND FLIGHT TEST THE SUPERCRITICAL WING-WHICH IS BELIEVED CAPABLE OF EFFICIENT CRUISING FLIGHT NEAR SONIC SPEED (I. E.,  $M = 0.97$  TO  $0.99$ ). THE F-8 AIRCRAFT WITH THE SUPERCRITICAL WING WILL BE UTILIZED TO (1) DEMONSTRATE THE HIGH FORCE-BREAK MACH NUMBERS AND IMPROVE MANEUVER CAPABILITY INDICATED IN THE WIND-TUNNEL TESTS, (2) IDENTIFY PROBLEM AREAS IN STRUCTURAL AND AERODYNAMIC DESIGN AND FLIGHT OPERATIONS, AND (3) ESTABLISH THE DESIRED LEVEL OF CONFIDENCE IN PREDICTION TECHNIQUES FOR FUTURE APPLICATIONS.

RTOP NO. 789-40-10 TITLE: REUSABLE NUCLEAR STAGE  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: HARRIS, R. J. TEL. 205-453-5584  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS PROJECT IS THE DEVELOPMENT OF A REUSABLE EARTH ORBIT BASED STAGE POWERED BY THE NERVA NUCLEAR ENGINE. THIS STAGE WILL BE USED TO SHUTTLE MANNED OR UNMANNED PAYLOADS BETWEEN THE BASE ORBIT AND LUNAR AND GEOSYNCHRONOUS ORBITS, TO LAUNCH UNMANNED DEEP SPACE PROBES, AND TO PROVIDE PROPULSION FOR THE MAJOR MANEUVERS OF MANNED PLANETARY MISSIONS. AS CURRENTLY ENVISIONED, THE NUCLEAR STAGE WILL BE PLACED INTO THE BASE EARTH ORBIT BY A TWO STAGE SATURN V VEHICLE. THE PAYLOADS AND ANY ADDITIONAL FUEL REQUIRED WILL BE TRANSPORTED TO ORBIT BY THE CHEMICAL SPACE SHUTTLE. A FLIGHT TEST IN 1977 IS CURRENTLY PLANNED, WITH OPERATIONAL STATUS BEING ACHIEVED IN 1978. THE BASIC THERMODYNAMIC ADVANTAGE (HIGH SPECIFIC IMPULSE) OF THE NUCLEAR ROCKET, AS COMPARED TO THE CHEMICAL ROCKET, IS WELL KNOWN AND HAS BEEN DEMONSTRATED EXPERIMENTALLY MANY TIMES IN REACTOR AND ENGINE TESTS. MANY MISSION ANALYSES, BASED ON USE OF A NUCLEAR ROCKET OF THE NERVA TYPE, HAVE SHOWN THE UTILITY AND PERFORMANCE ADVANTAGE OF NUCLEAR ROCKETS. IN CONCERT WITH A LOW COST CHEMICAL SPACE SHUTTLE, A REUSABLE NUCLEAR STAGE OFFERS ECONOMICAL TRANSPORTATION BEYOND EARTH ORBIT. STUDIES OF EXPENDABLE NUCLEAR STAGE INITIATED IN JULY 1969, WITH FY69 FUNDS HAVE BEEN REORIENTED TO INVESTIGATE REUSABLE STAGE CONCEPTS. IT IS PLANNED TO USE FY70 FUNDS TO CONTINUE THESE STUDIES AND PERFORM OTHER STUDIES NECESSARY TO COMPLETE A PHASE A SYSTEM DEFINITION.

RTOP NO. 902-42-15 TITLE: DEVELOPMENT OF OPERATIONAL REQUIREMENTS  
FOR LAND LANDING SPACECRAFT STUDIES

ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: MCKENNY, R. TEL. 713-483-4422  
TECHNICAL SUMMARY

OBJECTIVE: TO DEVELOP THE OPERATIONAL REQUIREMENTS FOR TERMINAL LANDING OPERATIONS OF THE SHUTTLE SPACECRAFT. APPROACH: THE LRO HAS BEEN AND IS CURRENTLY PERFORMING ANALYTICAL STUDIES AND OPERATIONAL EVALUATIONS OF VARIOUS MISSION CONCEPTS. THIS WORK HAS INCLUDED: 1. THE DEVELOPMENT OF PROCEDURES AND SYSTEMS TO SUPPORT THE LOW VELOCITY DESCENT SYSTEMS CONCEPT. 2. THE COLLECTION OF ANALYSIS OF ENVIRONMENTAL DATA FOR SPECIFIC CONCEPTS. 3. THE DEFINITION, IMPLEMENTATION, AND EVALUATION OF ONBOARD DISPLAYS.

RTOP NO. 908-41-01 TITLE: SPACE STATION STRUCTURAL  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: GRIFFITH, G. E. TEL. 713-483-3166  
TECHNICAL SUMMARY

THE OBJECTIVE IS TO SUPPORT EFFICIENT ANALYTICAL AND EXPERIMENTAL TECHNIQUES, BOTH STATIC AND DYNAMIC, USED IN THE DESIGN, QUALIFICATION, AND ACCEPTANCE OF ADVANCED SPACECRAFT SUPPORTING A MANNED SPACE STATION. THE SPACE STATION STRUCTURE WILL BE CONSIDERABLY DIFFERENT FROM CURRENT SPACECRAFT, MUCH LARGER, RELATIVELY LIGHTER, LESS STIFF, BE EXPOSED TO THE SPACE ENVIRONMENT MUCH LONGER, AND WILL HAVE FAR DIFFERENT DYNAMIC CHARACTERISTICS. THE EFFECTS OF ROTATION IN SPACE, MOVEMENT OR SELECTING OF MEN AND EQUIPMENT, DOCKING AND UNDOCKING, THERMAL CHANGES, ETC., REQUIRE CAREFUL STUDY IN ORDER TO MAINTAIN STABILITY AND CONTROL; IN ADDITION, THE STRUCTURAL COMPONENTS MUST WITHSTAND THE TOTAL LAUNCH ENVIRONMENT. NEW STRUCTURAL AND MECHANICAL CONCEPTS MUST BE EXAMINED AND ROTARY EFFECTS INCLUDED IN THE ANALYSES. BOTH STATIC AND DYNAMIC REPLICA MODELS MUST BE USED IN THE LABORATORY BECAUSE OF THE TREMENDOUS OVERALL SIZE OF THE SPACE STATION. TESTING TECHNIQUES WITHIN EXISTING FACILITIES WILL ALSO BE EXPLORED.

RTOP NO. 908-41-02 TITLE: SPACE STATION THERMAL CONTROL  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: GRIFFITH, G. E. TEL.  
TECHNICAL SUMMARY

THIS RTOP WILL DELINEATE THE REQUIRED EFFORT TO SUPPORT ADVANCED MANNED MISSIONS IN THE AREA OF ACTIVE THERMAL CONTROL SYSTEMS. INCLUDED WILL BE: (A) ENVIRONMENTAL DEFINITION ACTIVITY TO ENSURE ADEQUATE DESIGN CRITERIA AVAILABILITY AT THE TIME OF MISSION DEFINITION; (B) ANALYSIS TECHNOLOGY ENHANCEMENT THROUGH THEORY FORMULATION AND COMPUTATIONAL TECHNIQUE DEVELOPMENT; AND (C) THE CONVERSION OF FLIGHT HARDWARE OR OART SPONSORED HARDWARE CONCEPTS (WHICH HAVE PROVE FEASIBILITY) INTO FLIGHT PROTOTYPE SYSTEMS BY APPLYING THE TECHNOLOGY ADVANCES TO THE SPECIFIC PROBLEMS OF HEAT REJECTION SYSTEMS WITH VEHICLE AND MISSION FLEXIBILITY. RESULTS OF THIS TASK WILL PROVIDE MORE EFFICIENT ANALYTICAL TOOLS FOR THERMAL DESIGN, FOR SPACE STATION THERMAL CONTROL SYSTEMS.

RTOP NO. 908-41-05 TITLE: SPACE STATION ELECTRICAL POWER  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: RICE, W. E. TEL. 713-483-5273  
TECHNICAL SUMMARY

FOR A LARGE SPACE STATION, THE REQUIREMENTS FOR A GREAT AMOUNT OF ELECTRICAL POWER WILL REQUIRE PRACTICAL AND EFFICIENT APPROACHES TO POWER DISTRIBUTION, CONDITIONING, AND CONTROL. BOTH HIGH AND LOW CURRENTS AT MANY LOCATIONS WILL NEED TO BE HANDLED. INTEGRATED SYSTEMS ENGINEERING IN THIS AREA WILL CONTINUE TOGETHER WITH THE HARDWARE DEVELOPMENT PROGRAMS FOR (1) STATIC INVERTERS (MODULAR CONFIGURATION) (2) SOLID-STATE SEQUENCERS; (3) SOLID-STATE CIRCUIT BREAKERS FOR PROTECTION SYSTEM REFERENCED ABOVE; (4)

HIGH-CURRENT/HIGH VOLTAGE, REMOTELY CONTROLLED CONNECTORS RELAYS; AND MOTOR SWITCHES; (5) POWER TRANSFER MECHANISM FOR ROTARY INTERFACE (6) DI LINE VOLTAGE REGULATORS AND SIMILAR POWER CONDITIONING EQUIPMENT; AND (7) SPECIAL PURPOSE WIRING AND CONNECTORS. THE NUCLEAR REACTOR POWER GENERATION SYSTEM IS SCOPED WITHIN THIS RTOP TOGETHER WITH PHOTOVOLTAIC ARRAY/BATTERY SYSTEM AND POSSIBLE FUEL CELL APPLICATION.

RTOP NO. 908-41-06 TITLE: SPACE STATION LIFE SUPPORT  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: GUY, W. W. TEL. 713-483-3771  
TECHNICAL SUMMARY

THE ETC/LSS (ENVIRONMENTAL/THERMAL CONTROL AND LIFE SUPPORT SYSTEM) DEVELOPMENT EFFORT PROPOSED IS PREDICTED ON THE UTILIZATION OF EXISTING TECHNOLOGY TO ACHIEVE EACH OF THE ETC/LSS FUNCTIONAL REQUIREMENTS. THE APPROACH MINIMIZES THE CONSTRAINT OF EXTENSIVE DEVELOPMENT REQUIREMENTS, THEREBY MAXIMIZING HARDWARE IMPLEMENTATION EFFORTS. THIS APPROACH IS BEING ACCOMPLISHED BY SELECTING SUBSYSTEMS CONCEPTS OF PROVE FEASIBILITY (THAT IS THOSE SUBSYSTEMS WHICH HAVE BEEN PREVIOUSLY FABRICATED AND TESTED AS PROTOTYPES). MUCH USE IS BEING MADE OF PREVIOUS MSC EFFORTS, THE RESEARCH AND DEVELOPMENT EFFORTS OF LANGLEY RESEARCH CENTER, AND WRIGHT PATTERSON AIR FORCE RESEARCH. IN FACT, ALL SUBSYSTEM CONCEPTS BEING UTILIZED HAVE HAD THE BENEFIT OF GOVERNMENT DEVELOPMENT-FUNDING.

RTOP NO. 908-41-07 TITLE: SPACE STATION COMMUNICATIONS  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: KOSISKI, R. E. TEL. 713-483-2871  
TECHNICAL SUMMARY

THIS RTOP COVERS THE OVERALL COMMUNICATIONS ASPECT OF THE SPACE STATION. IT INVOLVES THE COMMUNICATIONS PROCESS TO THE STATION, ON BOARD THE STATION, AND FROM THE STATION TO OTHER VEHICLES AND THE GROUND NETWORKS. SYSTEM DESIGN ANALYSES ARE CONTINUING TOGETHER WITH HARDWARE DEVELOPMENTS, TESTS, AND EVALUATIONS. MAJOR INTERFACE REQUIREMENTS REFLECTING MISSION REQUIREMENTS AND OPERATIONAL MODES ARE CONSIDERED.

RTOP NO. 908-41-10 TITLE: SPACE STATION GUIDANCE, NAVIGATION, AND CONTROL  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: XENAKIS, G. TEL. 713-483-5018  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO DEVELOP GUIDANCE NAVIGATION AND CONTROL SYSTEM TECHNIQUES AND CONCEPTS WHICH WILL PROVIDE THE NEEDED SPACE BASE GUIDANCE AND CONTROL FUNCTIONS AND AT THE SAME TIME MINIMIZE THE OPERATIONAL COST OVER THE EXTENDED DURATION LIFETIME OF THE PROGRAM. GUIDANCE AND CONTROL SYSTEMS MUST BE DEVELOPED HAVING EXTREMELY LOW FAILURE RATES AND WHICH, IN ADDITION, MUST COPE WITH SOME VERY DEMANDING REQUIREMENTS. THE ASSEMBLY OF THE LARGE AND

MASSIVE SPACE BASE ELEMENTS WILL REQUIRE THE DEVELOPMENT OF UNMANNED RENDEZVOUS AND DOCKING TECHNIQUES MISSION PAYLOADS SUCH AS THE EARTH RESOURCES SURVEY EQUIPMENT, ZERO-G EXPERIMENTS, AND SOLAR AND STELLAR EXPERIMENTS PROVIDE THE DESIGN/PERFORMANCE REQUIREMENTS FOR MUCH OF THIS HARDWARE.

RTOP NO. 908-41-12 TITLE: SPACE STATION DISPLAY  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: MCCULLOUGH, C. E. TEL. 713-483-3987  
TECHNICAL SUMMARY

THIS EFFORT IS TO PROVIDE THE SPACE BASE DIRECTOR AND HIS ASSISTANTS WITH INFORMATION ACQUISITION PROCESSING, AND DISPLAY/CONTROL REQUIRED IN THE PLANNING, DIRECTING, AND CONTROLLING OF SPACE BASE OPERATIONS, AND RELATED OPERATIONS EXTERNAL TO THE SPACE BASE. TOWARD THIS END, THIS RTOP IS TO DEVELOP A FLEXIBLE CONTROL AND DISPLAY SYSTEM FOR THE MONITORING AND CONTROLLING OF THESE FUNCTIONS.

RTOP NO. 908-41-13 TITLE: SPACE STATION INSTRUMENTATION  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: RIEGERT, D. TEL. 713-483-4861  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO DEVELOP A NEW GENERATION OF SPACE HARDWARE SPECIFICALLY ORIENTED TOWARDS THE IMPLEMENTATION OF REQUIREMENTS UNIQUE TO A MANNED SPACE STATION. THE HARDWARE TO BE DEVELOPED ENCOMPASSES THREE DISTINCT AREAS OF OPERATIONAL SPACECRAFT PROGRAMS. THESE AREAS ARE: MEASUREMENT SYSTEMS DISPLAYS AND CONTROLS, AND CAUTION AND WARNING SYSTEMS. THE ADVANTAGES TO BE DERIVED REVOLVE PRIMARILY ABOUT OPTIMAL INTEGRATION TECHNIQUES BASED ON EXPERIENCE WITH APOLLO SYSTEMS AND THE AVAILABILITY OF NEW TECHNOLOGIES. THIS PHILOSOPHY WILL PRECLUDE THE NECESSITY OF MODIFYING WHATEVER EQUIPMENT EXISTS AT THE TIME TO MEET REQUIREMENTS WHICH CAN NOW BE DEFINED. THREE PRIMARY AREAS WITHIN THE INSTRUMENTATION SYSTEM CAN BE IDENTIFIED WHICH REQUIRE DEVELOPMENT EFFORT. THEY ARE THE SPACECRAFT I----

RTOP NO. 908-41-18 TITLE: SPACE STATION CHECK OUT  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: MARLOWE, G. D. TEL. 713-483-6196  
TECHNICAL SUMMARY

THE PRESENT GROUND CHECKOUT SYSTEM IS NO IN CONSONANCE WITH EXPRESSED S/S DESIGN GOALS FOR AN ECONOMICAL LOGISTIC VEHICLE SUPPORT PROGRAM, AND THE REQUIREMENTS FOR ONBOARD CHECKOUT SYSTEMS. THE PRESENT CHECKOUT SYSTEM REQUIRES NUMEROUS CHECKOUT FACILITIES, SPECIAL GROUND SUPPORT HARDWARE, AND AN EXPENSIVE ON-LINE MAN POWER SUPPORT EFFORT. GROUND CONTROL AND DISPLAY INTERFACE HARDWARE AND S/C SYSTEM INTERFACES MUST BE DEVELOPED; ALONG WITH THE SUPPORTING COMPUTER PROGRAMS, WHICH ALLOWS THE GROUND ELEMENTS TO SUPPORT AND



PERFORM FACTORY, THROUGH LAUNCH, AND REFURBISH CHECKOUT IN AN AUTOMATIC MODE WITH THE MINIMAL OF SPECIAL SUPPORT GS E AND MANNED OPERATOR SUPPORT. ALSO THE OBJECTIVE OF THIS DEVELOPMENT EFFORT IS TO PROVIDE THE REQUIRED ONBOARD CHECKOUT SYSTEM FOR THE SPACE BASE SYSTEMS. THIS SYSTEM WILL ALLOW FOR THE COMPLETE ANATOMY OF THE SPACE BASE AND ITS LOGISTIC VEHICLE BY PROVIDING A COMPUTERIZED SYSTEM FOR DATA ACQUISITION, PROCESSING, AND DISPLAY. THE PROVISIONING OF THE FUNCTIONS WILL ALLEVIATE THE PERSONNEL OF THE SPACE STATION OF HAVING TO PERFORM THE DETAILED SUBSYSTEM CHECKS AND CONTINUOUS STATUS MONITORING OF THE BASE SYSTEMS AND EXPERIMENTS.

RTOP NO. 908-41-30 TITLE: BIOMEDICAL BEHAVIOR

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: HULL, W. E. TEL. 713-483-6291

TECHNICAL SUMMARY

TO QUALIFY MAN FOR SPACE FLIGHT OF LONG DURATION AND TO MAKE SUCH FLIGHTS SAFE BY PROVIDING THESE FACTORS WHICH MAKE LIFE SAFE WITHIN A HOSTILE ENVIRONMENT. THE TASKS IN THIS EFFORT ARE ARRANGED IN FIVE CATEGORIES: BIOMEDICAL TECHNOLOGY, OPERATIONAL PROCEDURES, SPACECRAFT ENVIRONMENT, PHYSIOLOGICAL FACTORS, AND HABIT ABILITY. EMPHASIS IS ON CREW SAFETY, CREW SUSTENANCE, CREW BEHAVIOR, AND INVESTIGATIVE PROCEDURES TO BETTER UNDERSTAND THE CONDUCT AND WELFARE OF A MAN AS A MEMBER OF A FLIGHT CREW.

RTOP NO. 908-41-33 TITLE: ON BOARD COMPUTER DESIGN AND  
COMPATIBILITY FOR THE SPACE STATION AND  
IT'S ASSOCIATED LOGISTICS VEHICLE

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: HULL, W. E. TEL. 713-483-6291

TECHNICAL SUMMARY

THIS STUDY IS TO PROVIDE NASA WITH A REPORT TO BE USED IN AIDING SPECIFICATION OF BASIC DESIGN CONCEPTS FOR AN EARTH ORBIT SPACE STATION (EOSS) COMPUTER AND COMPATIBLE COMPUTER FOR SPACECRAFT ASSOCIATED WITH THE EOSS.

RTOP NO. 908-41-35 TITLE: SPACE STATION SYSTEMS ENGINEERING

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: JOHNSON, C. C. TEL. 713-483-3491

TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS SYSTEMS ENGINEERING PROGRAM IS TO FOCUS ATTENTION ON DEVELOPMENT PROBLEMS OF ADVANCED SPACE STATION SYSTEMS AND THE SOLUTION OF THESE PROBLEMS BY EXPERIMENT AND SUPPORTING ANALYSIS. EMPHASIS IS PLACED ON MAJOR SYSTEMS EMBRACING MULTIPLE SUBSYSTEM DISCIPLINES INCLUDING DEVELOPMENT OF SPACECRAFT MODULES, ASSOCIATED DEVELOPMENTS OF KEY ELEMENTS, AND INTEGRATION OF ADVANCED SUBSYSTEMS AT MOCKUP THROUGH PROTOTYPE LEVELS. THE SYSTEMS ENGINEERING APPROACH WAS SELECTED FOR ECONOMY SINCE IT PERMITS THE USE OF A SINGLE PROTOTYPE MODEL REQUIRED FOR REALISM TO BE TESTED IN

A NUMBER OF DISCIPLINES VS. SEPARATE MODELS FOR EACH DISCIPLINE. ALSO INCLUDED IS THE OBJECTIVE DIRECTED TOWARD DETERMINING THE OPTIMUM USE OF MAN'S CAPABILITIES IN FULFILLING THE OPERATIONAL REQUIREMENTS OF A MANNED SPACE STATION AND DETAILING THIS DATA IN TERMS OF DESIGN CRITERIA TO PROMOTE AN EFFECTIVE ASTRONAUT/SPACE STATION INTERFACE.

RTOP NO. 908-41-36 TITLE: SPACE STATION MECHANICAL SYSTEMS  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: JOHNSON, C. C. TEL. 713-483-3491  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS PROJECT ARE TO DEFINE AND AID IN THE DEVELOPMENT OF AN ADVANCED DOCKING SYSTEM FOR MISSIONS BEYOND APOLLO AND AAP, INCLUDING THE SPACE STATION AND LOGISTIC SPACECRAFT, AND TO DEFINE TECHNIQUES AND MECHANICAL SYSTEMS UNIQUE TO ORBITAL ASSEMBLY OF SEPARATELY LAUNCHED MODULES INTO A LARGE SPACE STATION (SPACE BASE" CONCEPT FOR EXAMPLE). THIS STUDY EFFORTS WILL DEFINE THE REQUIREMENTS AND CRITERIA FOR DOCKING AND ORBITAL ASSEMBLY, ESTABLISH DOCKING SYSTEM CONCEPTS, AND DEVELOP PRELIMINARY DESIGNS OF DOCKING SYSTEM MECHANICAL HARDWARE. A MODEL OF THE SELECTED DOCKING MECHANISM WILL BE FABRICATED AND TESTED ON THE EXISTING DYNAMIC DOCKING TEST FACILITY AT MSC TO VERIFY ITS PERFORMANCE. THIS EFFORT WILL BE COORDINATED WITH STUDIES IN THE AREAS OF GUIDANCE AND CONTROL, PROPULSION, AND STRUCTURES TO INSURE AN OPTIMUM OVERALL TECHNICAL APPROACH.

RTOP NO. 908-41-37 TITLE: SPACE STATION CRYOGENIC STORAGE SYSTEMS  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: RICE, W. E. TEL. 713-483-5273  
TECHNICAL SUMMARY

THE PRIMARY OBJECTIVE OF THIS TASK IS TO DESIGN, DEVELOP, AND QUALIFY CRYOGENIC STORAGE SYSTEMS (CSS) FOR VARIOUS APPLICATIONS. IN THE BROAD SENSE THE GOAL IS TO OBTAIN LARGER CRYOGENIC STORAGE SYSTEMS WITH LONGER MISSION DURATION CAPABILITY. CRYOGENIC TECHNOLOGY FOR SPACE APPLICATION IS A HIGHLY SPECIALIZED DISCIPLINE AND IS NOT RESTRICTED TO ANY ONE SPECIFIC SUBSYSTEM. BECAUSE OF THIS FACT, THERE ARE MANY ASSOCIATED RTOP'S IN THE AREAS OF PROPULSION, AUXILIARY PROPULSION, LIFE SUPPORT, AND SUPPORT OF SPACE-BORNE EXPERIMENTS WHICH RELATE TO THIS RTOP. ALTHOUGH MANY AREAS OF THIS TASK WILL NOT HAVE AN APPLICATION FOR NEARLY 5 YEARS, THE REQUIRED TECHNOLOGY PROCESS AND DEVELOPMENTAL LEAD TIME DICTATE THAT THE STUDY PHASES START IMMEDIATELY. ALSO, THIS TASK WILL CONSIDER THE DEVELOPMENT AND EVALUATION OF ASSOCIATED TECHNOLOGICAL ASPECTS OF CRYOGENIC STORAGE; FOR EXAMPLE, THE DEVELOPMENT OF A REFRIGERATION SYSTEM FOR ACTIVE COOLING IS A TECHNOLOGY WHICH IS DIRECTLY RELATED TO THE CSS.

RTOP NO. 908-41-38 TITLE: SPACE STATION MATERIALS  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: RADNOSKY, M. I. TEL. 713-483-3343  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO DEVELOP THOSE ADVANCED NONMETALLIC MATERIALS WHICH WILL BE REQUIRED IN THE DESIGN AND FABRICATION OF SPACE STATION AND RELATED EQUIPMENT. AS SPACE MISSIONS BECOME MORE SOPHISTICATED IT IS IMPARATIVE THAT MATERIAL STATE-OF-THE-ART KEEP PACE WITH INCREASINGLY STRINGENT REQUIREMENTS. THE SIGNIFICANT PACE OF ADVANCEMENT MADE IN NONMETALLIC MATERIALS FROM MERCURY THROUGH APOLLO MUST BE CONTINUED INTO FUTURE MISSIONS OF SPACE STATION CONFIGURATIONS. ADVANCED MATERIALS DEVELOPMENT WILL OCCUR IN TWO CATEGORIES: (1) INCREASE THE PERFORMANCE AND RELIABILITY OF MATERIALS DEVELOPED FOR PRESENT PROGRAMS (SOME MATERIALS, WHILE SATISFYING DEMANDS, WILL NOT BE ADEQUATE FOR THE SPACE STATION MISSIONS), AND (2) DEVELOPMENT OF NEW MATERIALS FOR REQUIREMENTS NOT HERETOFORE DEFINED. ALSO, THE PURPOSE OF THIS EFFORT IS TO DELINEATE THE PROBLEMS AND CONCEPTUALIZE THE SOLUTIONS INVOLVED IN IN-SPACE REPAIRABILITY, RECOATABILITY, AND CLEANABILITY OF THERMAL CONTROL COATINGS FOR LONG TERM (5 YEARS) MANNED ORBITAL MISSIONS. IT IS ANTICIPATED THAT THERMAL CONTROL COATINGS WITH 5-YEAR SPACE STABILITY WILL NOT BE AVAILABLE OR OF PROVEN RELIABILITY FOR USE ON MANNED VEHICLES DURING THE FORTHCOMING TIME PERIOD, AND THE PROBLEMS OF REPAIRABILITY WILL BE A MAJOR CONSIDERATION.

RTOP NO. 908-42-05 TITLE: EARTH ORBIT LOGISTICS-ELECTRICAL POWER  
(FUEL CELL)  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: RICE, W. E. TEL. 713-483-5273  
TECHNICAL SUMMARY

OBJECTIVE IS TO CONTINUE DEVELOPMENT OF THE AAP CAPILLARY MATRIX FUEL CELL UNDER A MINIMUM DEVELOPMENT, LOW RISK PROGRAM TO SUPPORT THE POWER SYSTEM REQUIREMENTS OF THE SPACE SHUTTLE. SPECIFICALLY, ANALYSES AND DESIGN MODIFICATIONS WILL BE PERFORMED TO SOLVE PRESENT LIFE-LIMITING TECHNICAL PROBLEMS, TO PROVIDE PRELIMINARY INTEGRATION/OPERATIONS DATA, AS DESIGN INPUTS, AND TO EXTEND/IMPROVE THE FUEL CELL CAPABILITY. ALSO, FABRICATION AND TEST VERIFICATION OF THE REDESIGNED HARDWARE WILL BE PERFORMED.

RTOP NO. 908-42-07 TITLE: APPLICATION OF SPACE PROGRAMMING LANGUAGE  
TO ONBOARD DATA PROCESSING SYSTEMS  
ORGANIZATION: MANNED SPACECRAFT CENTER  
MONITOR: RICE, W. E. TEL. 713-483-2408  
TECHNICAL SUMMARY

STUDY PURPOSE: DETERMINE THE FEASIBILITY OF APPLYING THE RESULTS OF THE PRESENT STUDY BEING DONE UNDER NAS12-2005 TITLED, "COMPUTER LANGUAGE FOR AERONAUTICS AND SPACE PROGRAMMING", TO SPACE VEHICLE ON-BOARD DATA PROCESSING SYSTEMS. PRINCIPAL CONTRACTOR TASKS  
1. DEVELOP A COMPLIER AS SPECIFIED UNDER NAS12-2005. 2. PROVIDE DOCUMENTATION DEFINING THE COMPLIER (ASSUMES USERS GUIDE WILL BE

PRODUCED UNDER NAS12-2005). 3. PREPARE EXISTING APOLLO PROGRAMS IN SPACE PROGRAMMING LANGUAGE (SPL) AND RUN COMPARISON STUDIES PERTAINING TO MEMORY ALLOCATION, EXECUTION TIME, EXECUTIVE CAPABILITIES, ETC.

RTOP NO. 908-42-10 TITLE: LOGISTICS S/C GUIDANCE, NAVIGATION, AND CONTROL

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: XENAKIS, G. TEL. 713-483-5018

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO DEVELOP GUIDANCE NAVIGATION AND CONTROL TECHNIQUES WHICH WILL PROVIDE THE NEEDED SYSTEM PERFORMANCE AND REDUNDANCY TO ACHIEVE A VERY HIGH PROBABILITY OF TRANSPORTATION SYSTEM SUCCESS. SIMPLE REDUNDANCE NAVIGATION AND GUIDANCE CONTROL SYSTEMS WHICH ARE REUSEABLE AND CAPABLE OF PROVIDING THE COMPLETE MISSION GUIDANCE AND CONTROL FUNCTIONS FROM LAUNCH THROUGH RENDEZVOUS, DOCKING, DEORBIT, REENTRY AND LANDING MUST BE DEVELOPED. AS THE NUMBER OF TRANSPORTATION SYSTEM FLIGHTS BECOMES LARGE, THE POSSIBILITY OF INCURRING A FAILURE IN THE GUIDANCE NAVIGATION AND CONTROL SYSTEM INCREASES. IF THE MISSION MUST BE ABORTED DUE TO SUCH A FAILURE, THE COST OF THE FAILURE CAN BE QUITE SUBSTANTIAL. THUS, THE TRANSPORTATION SYSTEM GN&C MUST BE MADE RELIABLE ENOUGH TO KEEP THE FREQUENCY OF SUCH FAILURES VERY LOW. THE OVERALL LOGISTIC VEHICLE GN&C EFFORT WILL BE GUIDED BY AN INTEGRATED SYSTEM ANALYSIS EFFORT. INCLUDED IN THESE STUDIES WILL BE THE DETERMINATION OF MISSION FUNCTIONAL REQUIREMENTS, AND DESIGN CRITERIA.

RTOP NO. 908-44-05 TITLE: LUNAR TRANSPORTATION ELECTRICAL POWER SYSTEM

ORGANIZATION: MANNED SPACECRAFT CENTER

MONITOR: RICE, W. E. TEL. 713-483-5273

TECHNICAL SUMMARY

TO UTILIZE RESIDUAL PROPELLANTS FROM THE DESCENT STAGE OF THE LM TO PRODUCE ELECTRICAL POWER UTILIZING A TURBO-ALTERNATOR AS THE ENERGY CONVERSION DEVICE. THIS SYSTEM USES AN IMPULSE TURBINE WHEEL DIRECTLY COUPLED TO A BRUSHLESS A-C ALTERNATOR. THE UNIT HAS SELF-CONTAINED CONTROLS AND POWER CONDITIONING/REGULATION EQUIPMENT FOR SPACECRAFT-QUALITY ELECTRICAL POWER. THIS IS AN APPROACH FOR PROVIDING POWER TO THE LM AND LUNAR SURFACE EXPERIMENTS FOR AN EXTENDED STAYTIME.

RTOP NO. 908-51-02 TITLE: SPACE STATION THERMAL CONTROL

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: RICE, W. E. TEL. 205-453-1120

TECHNICAL SUMMARY

SUBTITLE: DESIGN AND DEVELOPMENT OF THERMAL CONTROL SYSTEMS FOR MANNED COMPARTMENTS AND AVIONIC EQUIPMENT OBJECTIVES: THE OBJECTIVE IS TO PROVIDE FOR PROGRESSIVE DEVELOPMENT OF THERMAL CONTROL CONCEPTS

AND HARDWARE, FROM THE COMPONENT LEVEL TO AN INTEGRATED SYSTEM, APPLICABLE FOR A LIFETIME OF 10 YEARS IN SPACE AND QUALIFIED FOR USE IN FLIGHT APPLICATIONS IN THE 1975 TIME FRAME. THE THERMAL CONTROL SUBSYSTEM WILL BE DESIGNED FOR LONG LIFE, MAINTAINABILITY, AND/OR CRITICAL COMPONENT REPLACEMENT IN SPACE. THIS EFFORT WILL PROVIDE DESIGN CRITERIA, HARDWARE DESIGN, BREADBOARDS AND FLIGHT CONFIGURATION HARDWARE FOR THE FOLLOWING THERMAL CONTROL SUBSYSTEMS: A. THERMAL CONTROL COATINGS B. HIGH PERFORMANCE INSULATION C. COOLANT FLUID D. RADIATORS, PUMPS, AND VALVES E. HEAT PIPES F. FUSIBLE MATERIAL G. LOUVERS H. THERMOELECTRIC DEVICES I. SOLAR REFLECTORS THERMAL CONTROL SUBSYSTEMS WILL BE INTEGRATED INTO SYSTEMS CONFIGURATIONS, WHERE APPLICABLE, AND GROUND SIMULATED TESTS PERFORMED. THE SYSTEMS TESTS PROGRAM WILL BE DESIGNED TO DEMONSTRATE THE PERFORMANCE AND RELIABILITY FOR SPACE STATION AND SHUTTLE VEHICLE APPLICATION.

RTOP NO. 908-51-04 TITLE: SPACE STATION ATTITUDE CONTROL PROPULSION SYSTEM

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: RICE, W. E. TEL. 205-453-1120

TECHNICAL SUMMARY

THIS PLAN IS TO ESTABLISH THE ATTITUDE CONTROL PROPULSION SYSTEM (ACPS) DESIGN OPERATIONAL METHODOLOGY AND COMPONENT REQUIREMENTS TO SATISFY THE MANNED SPACE STATION REQUIREMENTS AND DEMONSTRATE THE NECESSARY COMPONENT, SYSTEM AND OPERATIONAL TECHNOLOGY BY THE BEGINNING OF 1972. THIS EFFORT IS NECESSARY TO PROVIDE THE CAPABILITY TO MEET THE LONG DURATION AND LARGE IMPULSE NEEDS OF THE SPACE STATION WITH MINIMUM OF CREW ACTIVITY FOR REFURBISHMENT AND RESUPPLY.

THE PHASE I EFFORT CONSISTS PRIMARILY OF REQUIREMENTS ANALYSIS AND DEFINITION SUBSYSTEM SYNTHESIS, PRELIMINARY DESIGN AND TRADE ANALYSES, AND SELECTION OF BASELINE SUBSYSTEM(S) FOR DETAIL DESIGN AND EXPERIMENTAL EVALUATION AND DEMONSTRATION IN PHASE II. THE PHASE II EFFORT WILL BE A CONTRACTED EFFORT TO DETAIL DESIGN THE SELECTED BASELINE(S), AND EXPERIMENTALLY EVALUATE AND DEMONSTRATE THE CRITICAL COMPONENTS AND A BREADBOARD SUBSYSTEM. THIS CONTRACTED EFFORT WILL BE SUPPORTED BY THE APPROPRIATE INHOUSE EFFORT TO MONITOR AND ANALYZE THE EFFORT AND RESULTS, AND TO PREPARE THE APPROPRIATE REQUIREMENTS DOCUMENTS IN PREPARATION FOR THE POTENTIAL FOLLOW-ON DEVELOPMENT EFFORT.

RTOP NO. 908-51-05 TITLE: ELECTRICAL POWER GENERATION SYSTEMS

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: RICE, W. E. TEL. 205-453-1120

TECHNICAL SUMMARY

OBJECTIVE: TO IDENTIFY POTENTIAL PROBLEMS ASSOCIATED WITH THE INTEGRATION OF ELECTRICAL POWER SYSTEMS INTO THE SPACE STATION; TO INITIATE THE RESEARCH NECESSARY TO IDENTIFY AND DEVELOP APPROACHES TO POSSIBLE SOLUTIONS; AND TO PROVIDE THE POWER SYSTEMS NECESSARY FOR THE SHUTTLE THROUGH THE IMPROVEMENT AND DEVELOPMENT OF HIGH DENSITY/HIGH EFFICIENCY BATTERY SYSTEMS. APPROACH: ACTIVITY IN

THIS AREA WILL BE DIRECTED TOWARD PREPARING FOR THE INTEGRATION AND APPLICATION OF SPACE POWER SYSTEMS TO THE SPACE SYSTEM. THIS WILL INVOLVE DETERMINATION OF SYSTEM AND COMPONENTS RELIABILITY AND OPERATIONAL CHARACTERISTICS THROUGH LIFE TESTING, FUNDAMENTAL STUDIES LEADING TO THE IMPROVEMENT OF PHOTO VOLTAIC AND CHEMICAL GENERATION EQUIPMENT WILL CONTINUE, WITH INCREASING INVOLVEMENT IN IMPROVEMENT OF LIFETIME CHARACTERISTICS OF THESE SYSTEMS AND ASSOCIATED DISTRIBUTION SYSTEMS.

RTOP NO. 908-51-07 TITLE: COMMUNICATIONS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: RICE, W. E. TEL. 205-453-1120  
TECHNICAL SUMMARY

OBJECTIVE: TO INITIATE DEVELOPMENT OF LIGHTWEIGHT PHASED ARRAY DESIGNS FOR MULTI-PURPOSE COMMUNICATION LINKS. HIGH GAIN, RAPIDLY REPOINTABLE ANTENNAS WILL BE REQUIRED FOR EFFICIENT MULTI-STATION COMMUNICATION. APPROACH: CONDUCT IN-HOUSE INVESTIGATIONS OF APPLICABLE MATERIALS AND DESIGNS. FABRICATE AND TEST MODELS AND SELECT MOST PROMISING APPROACHES FOR FURTHER INVESTIGATION. DEVELOP SPECIFICATIONS FOR CONTRACTED DEVELOPMENT OF ADVANCED ANTENNA MODELS FOR ADDITIONAL IN-HOUSE TESTING AND EVALUATION.

RTOP NO. 908-51-08 TITLE: STABILIZATION AND CONTROL  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: RICE, W. E. TEL. 205-453-1120  
TECHNICAL SUMMARY

TO PROVIDE A BASE FOR SPACE STATION STABILIZATION AND CONTROL PROBLEM SOLUTIONS, LAWS, LOGIC AND PARAMETERS, AND CERTAIN ELEMENTS OF GYRO HARDWARE WILL BE DEVELOPED, ESSENTIAL TO SPACE STATION OR SPACE SHUTTLE OPERATIONAL MODES (I.E., FLIGHT, ORBIT, REENTRY AND LANDING). TO ESTABLISH APPLICABILITY OF EXISTING TECHNOLOGY AND IDENTIFY NECESSARY NEW TECHNOLOGY REQUIREMENTS, DEVELOPMENT, SIMULATION AND TESTING OF SOFTWARE AND HARDWARE ITEMS WILL BE UNDERTAKEN. RESULTS WILL THEN PERMIT SELECTION AND OPTIMIZATION OF ONE OF SEVERAL CANDIDATE SYSTEMS.

RTOP NO. 908-51-18 TITLE: CHECKOUT  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: RICE, W. E. TEL. 205-453-1120  
TECHNICAL SUMMARY

TO PROVIDE TECHNOLOGY FOR DEVELOPING CHECKOUT SYSTEMS AND TECHNIQUES. PROBLEMS IN FUNCTIONAL TESTING, SYSTEM INTEGRITY AND CHECKOUT PRINCIPLES WILL BE IDENTIFIED, AND SOLUTIONS DEVELOPED, AS SPACE STATION, SPACE SHUTTLE, AND LUNAR EXPLORATION VEHICLES ARE DESIGNED AND BUILT. INCREASING FREQUENCY OF LAUNCHES, CONTINUED NARROW LAUNCH WINDOWS, LONGER FLIGHT TIMES, AND A GROWING COMPLEXITY OF VEHICLE STRUCTURES AND THEIR MATERIALS MILITATE AGAINST SHORTENING OF TURNAROUND-TIME AT THE LAUNCH PAD. THE SOLUTION LIES IN MORE



SOPHISTICATION OF TEST AND CHECKOUT PROCEDURES AND OPERATION, AND A REDUCTION OF PERSONNEL AND EQUIPMENT TO DO FLIGHT MAINTENANCE. THIS IS REFLECTED IN THE THREEFOLD APPROACH OF THIS RTOP: A. CHECKOUT MALFUNCTION AND TREND ANALYSIS. B. APPLIED ANALYTICAL TECHNIQUES DEVELOPMENT FOR DETERMINATION OF ELECTRICAL/STRUCTURAL SYSTEMS/COMPONENTS. C. ELECTRONIC, ELECTROMECHANICAL AND PNEUMATIC PERFORMANCE TESTING.

RTOP NO. 908-51-21 TITLE: MANUFACTURING AND INSPECTION  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: RICE, W. E. TEL. 205-453-1120  
TECHNICAL SUMMARY

TO PROVIDE TECHNOLOGY FOR FABRICATION, PROCESS INSPECTION, ASSEMBLY AND SIMULATION TESTING OF SYSTEMS APPLICABLE TO A SPACE STATION AND A SPACE SHUTTLE. EQUIPMENT FOR SIMULATING A SPACE ENVIRONMENT, AND TECHNIQUES FOR DOING STUDIES WITHIN THE SIMULATED ENVIRONMENT, WILL BE DEVELOPED. THIS DEVELOPMENT WILL BE THE MATRIX FROM WHICH THE METHODS, PROCESSES, TOOLING, AND FACILITIES FOR MANUFACTURE OF PROTOTYPE SYSTEMS WILL EVOLVE. TO ATTAIN IMPROVED PERFORMANCE AND REPEATABILITY IN METAL-JOINING, INTERRELATED STUDIES OF POROSITY, STRESS, QUALITY CONTROL OF WELDMENTS, AUTOMATIC EQUIPMENT, AND PROCEDURES AND POWER DENSITY WILL BE ANALYZED AND INTEGRATED. AFTER INTEGRATION, TESTING AND INSPECTION METHODS FOR PROCESS AND MATERIAL CONTROL WILL BE ESTABLISHED.

RTOP NO. 908-51-33 TITLE: DATA MANAGEMENT  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: RICE, W. E. TEL. 205-453-1120  
TECHNICAL SUMMARY

OBJECTIVES: (1) TO ESTABLISH DATA EVALUATION CRITERIA & REDUNDANCY REMOVAL TECHNIQUES FOR SELECTED CLASSES OF SCIENTIFIC AND ENGINEERING DATA. (2) TO INVESTIGATE THE CONCEPTUAL DESIGN OF AN ON-BOARD DATA-INFORMATION MANAGEMENT SYSTEM FOR SPACE STATION AND SPACE SHUTTLE USE. (3) TO INVESTIGATE HARDWARE-SOFTWARE RELATIONS FOR SUCH A SYSTEM. APPROACH: GENERALIZED CRITERIA FOR THE SYSTEM ARE DEVELOPED. SPECIFIC SETS OF EXPECTED TYPICAL DATA WILL BE ANALYZED FOR "INFORMATION CONTENT" AND REDUNDANCY REMOVAL TECHNIQUES DEVELOPED AND TESTED. SEVERAL POTENTIALLY EFFICIENT SYSTEMS WILL BE DESIGNED IN CONCEPT AND ANALYZED. A MODEL SYSTEM WILL BE "DEVELOPED" TOGETHER WITH APPLICABLE HARDWARE. IT WILL BE SIMULATED AND EVALUATED. CRITERIA AND SPECIFICATIONS FOR SUBSYSTEMS -- INCLUDING INPUT SENSORS WILL BE DEVELOPED.

RTOP NO. 908-51-38 TITLE: MATERIALS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: RICE, W. E. TEL. 205-453-1120  
TECHNICAL SUMMARY

WITHIN THE LIMITED SCOPE OF WORK, MSFC PLANS TO PLACE EMPHASIS

ON DEVELOPING AND UTILIZING MATERIALS PRIMARILY RELATED TO SPACE SHUTTLE PROBLEMS. THE EMPHASIS WILL BE DIRECTED IN THE FOLLOWING AREAS: (A) THERMAL CONTROL; (B) MATERIALS & PROCESSING; (C) STRESS CORROSION; AND (D) INFLUENCE OF GASEOUS HYDROGEN ON MATERIALS. SEMICONDUCTOR DEVICES WILL BE DEVELOPED WHICH WILL BE USED AS THERMAL CONTROL COATINGS. PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF MATERIALS USED IN LIFE SUPPORT AND ENVIRONMENTAL CONTROL SYSTEMS WILL BE ATTACKED AND HOPEFULLY SOLVED. TEST DATA WILL BE DEVELOPED ON THE LONG TERM ENVIRONMENTAL EFFECTS OF VARIOUS SPACE LAUNCH VEHICLE FLUIDS ON STRUCTURAL ALLOYS, AND THE MECHANISMS INVOLVED IN STRESS CORROSION WILL BE DEVELOPED. THE EFFECTS OF GASEOUS HYDROGEN ON METAL ALLOYS WILL BE DETERMINED AND SAFE OPERATING PARAMETERS FOR THESE ALLOYS USED IN A GASEOUS HYDROGEN ENVIRONMENT WILL BE ESTABLISHED. IN-HOUSE CAPABILITIES WILL BE UTILIZED AT EVERY OPPORTUNITY.

RTOP NO. 908-52-02 TITLE: REUSABLE SPACE SHUTTLE VEHICLE THERMAL PROTECTION

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: RICE, W. E. TEL. 205-453-1120

TECHNICAL SUMMARY

THERMAL CONTROL SYSTEMS WILL BE DEVELOPED FOR THE REUSABLE SPACE SHUTTLE VEHICLE OF THE POST 1975 TIME FRAME. THIS WILL INCLUDE SELECTION OF CANDIDATE CONCEPTS AND MATERIALS WITH MATERIAL AND SCALE MODEL TESTS TO PROVIDE NECESSARY DATA AND VERIFY SELECTED CONCEPTS. QUALIFICATION TESTS OF THE MOST PROMISING SYSTEMS WILL BE MADE ON SCALE MODELS. THIS DEVELOPMENT WILL CONSIDER COST, WEIGHT, RELIABILITY, REFURBISHMENT COST AND DIFFICULTY, MATERIAL AVAILABILITY, AND APPLICABILITY OF CANDIDATE TECHNIQUES TO THE SELECTED ILRV CONFIGURATION.

RTOP NO. 908-52-03 TITLE: SPACE SHUTTLE PROPULSION SYSTEMS ONBOARD CHECKOUT & MONITORING SYSTEM DEVELOPMENT STUDY

ORGANIZATION: MARSHALL SPACE FLIGHT CENTER

MONITOR: VOSS, W. E. TEL. 000-453-4622

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS STUDY IS TO ESTABLISH THE PROPULSION SYSTEMS "ONBOARD" CHECKOUT, IN FLIGHT MONITORING, EMERGENCY DETECTION AND POSTFLIGHT EVALUATION SYSTEM CONFIGURATION AND REQUIREMENTS AND TO DETERMINE THEREFROM THE ENGINE AND VEHICLE SPECIFICATION REQUIREMENTS AND DESIGN CRITERIA. THE SYSTEM WILL ENABLE THE CREW TO DETERMINE THE FLIGHT WORTHINESS OF THE VEHICLE AND ITS COMPONENTS, PROVIDE A WARNING OF ACTUAL AND IMPENDING MALFUNCTIONS AND ASSIST IN THE REFURBISHMENT AND REPLACEMENT EFFORT BETWEEN FLIGHTS AND REDUCE OPERATIONAL COST. THE STUDY WILL INCLUDE THE MAIN, AUXILIARY AND AIR BREATHING PROPULSION SYSTEMS.

RTOP NO. 908-52-04 TITLE: SPACE SHUTTLE ATTITUDE CONTROL SYSTEM  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: VOSS, W. E. TEL. 205-453-1120  
TECHNICAL SUMMARY

THIS PLAN IS TO ESTABLISH THE ATTITUDE CONTROL SYSTEM CONFIGURATION, REQUIREMENTS AND INTERFACES FOR THE REUSABLE SPACE SHUTTLE VEHICLE AND TO DETERMINE THEREFR ON THE SYSTEM SPECIFICATIONS AND DESIGN CRITERIA. TWO PARALLEL STUDIES ENTITLED "ATTITUDE CONTROL SYSTEM DEFINITION AND REQUIREMENTS DESIGN STUDY" FUNDED AT ABOUT \$600K EACH IN FY 1970 AND RUNNING FOR ABOUT 24 MONTHS WITH A TOTAL RUNOUT COST ESTIMATED AT \$2.5M TO \$3.0M ARE PLANNED. SUPPORTING THESE STUDY CONTRACTS TWO ADDITIONAL PARALLEL CONTRACTS ARE PLANNED FOR BREADBOARDING CRITICAL SUBSYSTEMS, MOCKUPS AND SYSTEM LAYOUT. TOTAL COST FOR THESE TWO CONTRACTS IS ESTIMATED AT \$3M TO \$5M WITH FY '70 COSTS LIMITED TO \$600K (\$300K EACH). THESE CONTRACTS WILL RUN ABOUT 24 MONTHS.

RTOP NO. 908-52-10 TITLE: GUIDANCE AND NAVIGATION  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: VOSS, W. E. TEL. 205-453-1120  
TECHNICAL SUMMARY

OBJECTIVE: TO DETERMINE FUEL-OPTIMUM LAUNCH AND REENTRY TRAJECTORIES FOR HIGH LIFT-TO-DRAG VEHICLES. APPROACH: DETAILED ANALYSIS OF PROBLEM FORMULATION AND SOLUTION TECHNIQUES WILL GUIDE IN DETERMINING OPTIMUM TRAJECTORIES. PROBLEM FORMULATION WILL EMBRACE BOTH CONFIGURATION AND PARAMETER CHANGES ASSESSED OVER AN ENTIRE TRAJECTORY. THIS WILL INCLUDE: EVALUATION OF THE EFFECTS OF SEVERE ANGLE OF ATTACK RESTRICTIONS ON PAYLOAD DELIVERED TO ORBIT DURING ASCENT AND REENTRY; PARAMETRIC STUDIES OF PAYLOAD PENALTY VERSUS ANGLE-OF-ATTACK RESTRICTIONS. TRAJECTORIES FOR CANDIDATE VEHICLE/CONFIGURATIONS WILL BE SELECTED BY A COMPUTER PROGRAM FOR CALCULATING OPTIMAL ASCENT AND ALLOWABLE DESCENT TRAJECTORIES.

RTOP NO. 908-52-38 TITLE: MATERIALS AND ELEMENTS FOR AEROSPACE  
VEHICLE STRUCTURES  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: VOSS, W. E. TEL.  
TECHNICAL SUMMARY

ONE OF THE MOST WIDELY USED AND IMPORTANT GOVERNMENT HANDBOOKS IN USE TODAY IS MIL-HDBK-5, "METALLIC MATERIALS AND ELEMENTS FOR AEROSPACE VEHICLE STRUCTURES", WHICH COVERS DESIGN ALLOWABLES FOR METALS AND FASTENERS FOR SPACE VEHICLES, MISSILES, AND AIRCRAFT. IT IS REQUIRED BY NASA, DOD, AND FAA IN THE DESIGN OF ITEMS PURCHASED OR CONTROLLED BY EACH AGENCY. THE AIR FORCE, AS DOD'S AGENT, IS CURRENTLY CONTRACTING WITH THE BASTELLE MEMORIAL INSTITUTE TO REVISE AND MAINTAIN THE HANDBOOK. BECAUSE OF THE NEED TO UPDATE THE HANDBOOK, SO IT CAN EFFECTIVELY BE USED IN THE DESIGN OF THE UPCOMING GENERATION OF AEROSPACE VEHICLES BOTH NASA AND FAA ARE PROPOSING TO CONTRIBUTE TO ITS SUPPORT STARTING IN FY'70. THIS JOINT PROGRAM SHOULD RESULT IN (1) A BETTER HANDBOOK THUS PROVIDING MORE EFFICIENT

AND SAFER STRUCTURES IN AEROSPACE HARDWARE, AND (2) A REDUCTION IN COST TO THE GOVERNMENT BY MINIMIZING DUPLICATION NOW OCCURRING IN THE GENERATION OF DESIGN ALLOWABLES.

RTOP NO. 908-52-39 TITLE: AEROTHERMODYNAMICS  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: VOSS, W. E. TEL. 205-453-1120  
TECHNICAL SUMMARY

OBJECTIVE: TO ACQUIRE AERODYNAMIC-THERMODYNAMIC DATA ESSENTIAL TO THE SELECTION OF A SHUTTLE VEHICLE CONFIGURATION. TO ACQUIRE DATA BASIC TO THE SELECTION OF MATERIALS AND THE DESIGN OF STRUCTURES.  
APPROACH: IN-HOUSE AND CONTRACTUAL EFFORTS ANALYZING THE AEROTHERMODYNAMIC CHARACTERISTICS OF PROPOSED CONFIGURATIONS WILL BE PERFORMED AND MODEL ANALYSES WILL BE CONDUCTED. IN-HOUSE AND CONTRACTED EXPERIMENTAL TESTS UTILIZES MODELS IN WIND TUNNELS WILL BE RUN.

RTOP NO. 908-52-40 TITLE: STRUCTURAL DYNAMICS AEROELASTICITY  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: VOSS, W. E. TEL. 205-453-1120  
TECHNICAL SUMMARY

STRUCTURAL DYNAMICS AND AEROELASTICITY ARE GOING TO BE CRITICAL FOR THE SHUTTLE VEHICLE DUE TO THE COMPLEX AND ATYPICAL CONFIGURATION BEING CONSIDERED. A PROGRAM IS REQUIRED TO PROVIDE ACCURATE DYNAMIC MODELING RESPONSE AMPLITUDE AND LOAD CALCULATION METHODS AND COMPUTER PROGRAMS APPLICABLE TO THE COMPLEX COMBINATIONS OF STRUCTURES, PROPULSIVE SYSTEMS AND EQUIPMENT INVOLVED IN SPACE SHUTTLE. ANOTHER PROGRAM WILL DEVELOP AND EMPIRICALLY VERIFY METHODS FOR DETERMINING VIBRO-ACOUSTIC ENVIRONMENTS AND RESPONSES OF SPACE SHUTTLE STRUCTURES. A THIRD TASK WILL DEAL WITH THE REQUIREMENT THAT THE DYNAMIC BEHAVIOR BE PREDICTED WITH A HIGH ACCURACY TO INSURE LONG FATIGUE LIFE TIME, LOW BOOSTER WEIGHT, ADEQUATE CONTROL SYSTEM DESIGN, AND GOOD CREW PERFORMANCE. THIS LAST TASK WILL BE COMPOSED OF A NUMBER OF SUBTASKS.

RTOP NO. 908-71-31 TITLE: SPACE STATION EXPERIMENT PLANNING STUDIES  
ORGANIZATION: LANGLEY RESEARCH CENTER  
MONITOR: GARDNER, W. N. TEL. 703-827-3666  
TECHNICAL SUMMARY

THE OBJECTIVES OF THESE STUDIES ARE TO INTEGRATE CANDIDATE EXPERIMENT PAYLOADS FROM EXISTING EXPERIMENT LISTS FOR CURRENT SPACE STATION CONCEPTS IN ORDER TO ASSESS THE CONCEPT MISSION EFFECTIVENESS. THIS IS TO BE ACCOMPLISHED THROUGH UTILIZATION OF A PREVIOUSLY DEVELOPED SPACE STATION SIMULATION MATH MODEL.

RTOP NO. 908-73-20 TITLE: DEVELOPMENT OF SIMULATION SYSTEM FOR  
FLIGHT TESTS OF LUNAR FLYING VEHICLES  
(PROJECT FLEEP)

ORGANIZATION: LANGLEY RESEARCH CENTER

MONITOR: HEWES, D. C.

TEL. 703-827-3348

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS EFFORT IS TO DESIGN, BUILD, AND CHECK OUT A FLIGHT TEST SIMULATOR FOR STUDIES OF THE VEHICLE HANDLING QUALITIES AND OTHER PLOTTING PROBLEMS ASSOCIATED WITH SMALL LUNAR FLYING VEHICLES OF THE TYPE INTENDED FOR LUNAR EXPLORATION OVER DISTANCES UP TO 50 MILES. SPECIFICALLY, A FLYING TEST BED (FLEEP-FLYING LUNAR EXCURSION ENVIRONMENTAL PLATFORM) IS TO BE DESIGNED AND BUILT EMBODYING MANY OF THE PRINCIPLES AND DESIGN FEATURES REQUIRED OF THE PROPOSED LUNAR FLYING VEHICLE. THE FLEEP VEHICLE WILL BE INSTALLED AND TESTED ON THE LUNAR LANDING RESEARCH FACILITY (LLRF) WHICH IS BEING MODIFIED SPECIFICALLY FOR THIS PURPOSE UNDER 127-51-18. ONE OF THE FUNDAMENTAL PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF THE LUNAR FLYING VEHICLE IS THE UNCERTAINTY ABOUT THE PARTICULAR DESIGN FEATURES AND SYSTEM CHARACTERISTIC WHICH AFFECT THE ABILITY OF THE ASTRONAUTS TO PROPERLY FLY AND NAVIGATE WITH THIS VEHICLE. THIS UNCERTAINTY IS DUE TO THE COMPLETE LACK OF ANY PRIOR EXPERIENCE IN THE UNIQUE LUNAR ENVIRONMENT AND TO THE DIFFICULTIES IN REPRODUCING THE EQUIVALENT FLIGHT CONDITIONS HERE ON EARTH. THE LLRF IS THE ONLY CURRENTLY AVAILABLE FACILITY WHERE A MOVING BASE SIMULATION OF THESE LUNAR CONDITIONS CAN BE PROVIDED. THIS FACILITY HAS BEEN USED SUCCESSFULLY FOR THE PAST FEW YEARS IN RESEARCH AND ASTRONAUT TRAINING LEADING TO THE APOLLO LUNAR LANDING MISSIONS. THE INFORMATION TO BE GAINED FROM THE FLEEP TEST PROGRAM WILL BE AVAILABLE IN A TIMELY MANNER FOR DEVELOPMENT OF THE OPERATIONAL LUNAR VEHICLE AND FOR TRAINING OF THE ASTRONAUTS WHO WILL USE THE VEHICLE.

RTOP NO. 150-22-11 TITLE: NEW TRACKING AND DATA ACQUISITION SYSTEMS  
ORGANIZATION: GSFC  
MONITOR: HABIB, E. J. TEL. 301-982-4776  
TECHNICAL SUMMARY

THIS TASK AREA HAS SEVERAL OBJECTIVES IN FY 1970: TO DEFINE AND EVALUATE THE REQUIREMENT FOR TRACKING MANNED AND UNMANNED EARTH ORBITING SATELLITES FROM A GEOSYNCHRONOUS RELAY SATELLITE; TO DETERMINE THE OPTIMUM DEPLOYMENT OF THESE GEOSYNCHRONOUS SATELLITES AND EARTH CONTROL CENTERS FOR OPTIMUM UTILIZATION; DETERMINE MATHEMATICAL MODELS, TECHNIQUES, AND METHODS FOR ORBIT DETERMINATION; DETERMINE AND EVALUATE ELECTRO-MAGNETIC COMPATIBILITY AND MULTIPATH EFFECTS UPON TRACKING AND DATA RELAY USING GEOSYNCHRONOUS SATELLITES; DETERMINE THE TRANSPONDING TECHNIQUES FOR OPTIMUM OPERATION IN THESE ENVIRONMENTS; DETERMINE THE MOST COST EFFECTIVE UTILIZATION IN CONJUNCTION WITH PRESENT TEDA FACILITIES; DEFINE AND DEVELOP OPERATIONAL CONCEPTS AND REQUIREMENTS FOR A TDRSS; DEVELOP METHODS AND TECHNIQUES FOR MULTIPLE USER TRACKING AND DATA RELAY AT VHF AND MICROWAVE FREQUENCIES.

RTOP NO. 150-22-12 TITLE: INTEGRATED SYSTEMS ANALYSIS, DEVELOPMENT AND TEST (STADAN, MSFN)

ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: COATES, R. J. TEL. 301-982-4809  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS TASK ARE: IMPROVE THE EFFECTIVENESS OF STADAN VHF OPERATIONS IN THE PRESENCE OF IONOSPHERIC DISTURBANCES NEAR THE MAGNETIC EQUATOR; ESTABLISH CRITERIA FOR THE OPTIMUM PROPERTIES OF TIME CODES AND RECOMMEND CHANGES IN EXISTING CODES FOR ERROR-FREE TIME DISTRIBUTION; DEVELOP NEW TECHNIQUES AND METHODS OF TIME AND FREQUENCY SYNCHRONIZATION; DETERMINE THE MOST COST EFFECTIVE TESTING METHODS AND EQUIPMENTS FOR OPTIMALLY MAINTAINING THE NETWORK, BRINGING THE NETWORK UP TO READINESS FOR MISSIONS SUPPORT, AND/OR DECREASING THE NETWORK TURN-AROUND TIME; DETERMINE THE MINIMUM AMOUNT OF MSFN AUGMENTATION REQUIRED TO SUPPORT MISSIONS IN THE 1970 TO 1975 PERIOD; IMPROVE AND UPDATE THE GODDARD DEFINITIVE ORBIT DETERMINATION SYSTEM TO FULFILL EARTH, AND LUNAR ORBITAL ACCURACY REQUIREMENTS; DEVELOP AND IMPROVE COMPUTER PROGRAMS FOR SATELLITE STABILIZATION AND CONTROL ANALYSIS; AND DEVELOP RAPID AND ACCURATE COMPUTATIONAL ALGORITHMS TO SIMULATE CRITICAL EVENTS FOR THE ANALYSIS OF PLANETARY AND INTERPLANETARY MISSIONS.

RTOP NO. 150-22-13 TITLE: ANTENNA SUBSYSTEMS (STADAN, MSFN)  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: DURHAM, A. F. TEL. 301-982-4973  
TECHNICAL SUMMARY

EFFORT IN FY 1970 IN THIS TASK AREA IS DIRECTED TOWARD IMPROVING THE OVERALL PERFORMANCE, RELIABILITY AND MAINTAINABILITY OF STADAN AND MSFN ANTENNAS; DEVELOPING GREATER ANTENNA EFFICIENCY BY THE USE OF LOW NOISE FEED SYSTEMS AND ADVANCED ANTENNA TECHNIQUES; INCREASING OPERATIONAL FLEXIBILITY BY DEVELOPING MULTIPLE FREQUENCY



FEED SYSTEMS THAT ARE EFFICIENT; DEVELOPING COMPUTER PROGRAMS WHICH ARE ESSENTIAL TO THE DESIGN OF PRACTICAL, NON-IDEALIZED ANTENNAS; DESIGNING AND DEVELOPING ADAPTIVE AND DIGITAL CONTROL SYSTEMS; DEVELOPING NEW ANTENNA DRIVE SYSTEMS AND TECHNIQUES WHICH INCREASE RELIABILITY AND TROUBLE FREE PERFORMANCE; AND DEVELOPING PROCEDURES FOR AUTOMATING THE CHECKOUT AND OPERATION OF RF AND CONTROL SUBSYSTEMS.

RTOP NO. 150-22-14 TITLE: RECEIVER AND TRANSMITTER SUBSYSTEMS  
(STADAN, MSFN)

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: SIMAS, V. R. TEL. 301-982-4936

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS TASK AREA ARE TO DEVELOP RECEIVER AND TRANSMITTER SUBSYSTEMS TO MEET THE REQUIREMENTS OF THE GSFC TRACKING & DATA ACQUISITION NETWORKS. IN FY 1970, TO DEVELOP A COMPLETELY INTEGRATED, ALL-SOLID-STATE X-BAND PARAMP; COMPLETE THE DEVELOPMENT OF THE HYDROGEN MASER FREQUENCY STANDARD AND MEASURE ITS PERFORMANCE; COMPLETE THE DEVELOPMENT OF THE AUTOMATED MULTIFUNCTIONAL RECEIVER FOR OPERATION AT SPACE ALLOCATED FREQUENCY BANDS SATISFYING AUTOTRACK, RANGING AND TELEMETRY FUNCTIONS.

RTOP NO. 150-22-15 TITLE: DATA HANDLING AND CONTROL SUBSYSTEMS  
(STADAN, MSFN)

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: COATES, R. J. TEL. 301-982-4809

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS TASK AREA ARE TO DEVELOP A MORE EFFECTIVE DATA HANDLING AND CONTROL CONFIGURATION FOR STADAN AND MSFN STATIONS IN ORDER TO IMPROVE THE QUALITY OF OPERATIONS, INCREASE THE SATELLITE HANDLING CAPABILITY, AND REDUCE OPERATIONS COSTS; TO DEVELOP HIGH DENSITY RECORDING TECHNIQUES SUITABLE FOR ARCHIVAL APPLICATIONS; TO DEVELOP AN INSTRUMENTATION TAPE LINK HAVING THE IMPROVED PERFORMANCE PARAMETERS REQUIRED FOR FORTHCOMING STADAN ASSIGNMENTS; TO DESIGN AND DEVELOP THE DIGITAL COMMAND, CONTROL AND DISPLAY SUBSYSTEMS AND OPERATING PROCEDURES TO ACCOMPLISH COMPUTER CONTROL OF A SATELLITE TRACKING STATION.

RTOP NO. 150-22-16 TITLE: DATA PROCESSING AND REDUCTION SUBSYSTEMS  
(STADAN, MSFN)

ORGANIZATION: GODDARD SPACE FLIGHT CENTER

MONITOR: COATES, R. J. TEL. 301-982-4809

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS AREA ARE TO DESIGN, DEVELOP AND APPLY OPTICAL TECHNIQUES AND EQUIPMENT TO SIMPLIFY AND/OR ENHANCE DATA PROCESSING CAPABILITIES; TO DEVELOP EFFICIENT ERROR DETECTING AND CORRECTING CODING SYSTEMS FOR FUTURE SPACECRAFT COMMUNICATIONS AND TELEMETRY, WITH SPECIAL ATTENTION TO CONVOLUTIONAL CODES WITH BOTH

ALGEBRAIC AND PROBABILISTIC DECODING; DEVELOP DIAGNOSIS CAPABILITY FOR TELEMETRY DATA SYSTEMS WHEN DATA PROCESSING PERFORMANCE IS UNSATISFACTORY; DEVELOP A FLEXIBLE CAPABILITY FOR EFFICIENT PROCESSING OF TELEMETRY SIGNALS USING MATCHED FILTERS OR SIMILAR TECHNIQUES; EXPLOIT THE CAPABILITIES OF MICROELECTRONIC PACKAGING TECHNIQUES.

RTOP NO. 150-22-17 TITLE: SPACECRAFT SUBSYSTEMS (STADAN)  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: MULLER, R. M. TEL. 301-982-4043  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK AREA IS TO IMPROVE AND DEVELOP COMPLEMENTARY SPACECRAFT SUBSYSTEMS AND TECHNOLOGY TO PERFORM THE ELECTRONIC FUNCTIONS NECESSARY FOR EFFICIENT AND EFFECTIVE ACCOMPLISHMENT OF TRACKING AND DATA ACQUISITION (INCLUDING COMMAND CONTROL) IN SUPPORT OF UNMANNED, SCIENTIFIC MISSIONS. THIS TASK IS CONCERNED PRIMARILY WITH GENERAL-PURPOSE SPACECRAFT SUBSYSTEMS USED IN SEQUENCE AFTER SENSOR INFORMATION IS GENERATED AND BEFORE RF SIGNAL IS FED INTO THE SPACECRAFT ANTENNA, AND COVERS THE DEVELOPMENT OF (1) A UNIFIED INFORMATION SUBSYSTEM, AND (2) A UNIFIED RADIO-FREQUENCY SUBSYSTEM. THE COMMAND FUNCTIONS ARE DISTRIBUTED BETWEEN THESE TWO MAJOR SUBSYSTEMS.

RTOP NO. 150-22-18 TITLE: NETWORK PERFORMANCE AND OPERATIONS  
TECHNOLOGY (STADAN, MSPN)  
ORGANIZATION: GODDARD SPACE FLIGHT CENTER  
MONITOR: COATES, R. J. TEL. 301-982-4809  
TECHNICAL SUMMARY

THE OBJECTIVES OF THIS TASK AREA ARE TO IMPROVE NETWORK EFFICIENCY AND OPERATIONS BY REDUCING RFI IN SPACE-TO-EARTH AND EARTH-TO-SPACE SATELLITE RADIO LINKS; REDUCE STADAN AND MANNED FLIGHT STATION EQUIPMENT LOSSES CAUSED BY LIGHTNING. DEVELOP A DATA QUALITY PREDICTING PROGRAM FOR EVALUATING PERFORMANCE OF INDIVIDUAL TRACKING STATIONS AND PREDICTING EFFECTS OF RADIO LINK PARAMETER VARIATIONS ON PROCESSING-LINE DATA QUALITY. DEVELOP A SOFTWARE SYSTEM TO ANALYZE TRACKING DATA IN A POST-FLIGHT SENSE FROM EARTH ORBITING AND LUNAR AND PLANETARY MISSIONS WITH THE CAPABILITY OF DETERMINING TRACKING SYSTEMS ERROR MODELS AND THE NECESSARY ADJUSTMENT OF ASTRODYNAMIC AND POWERED FLIGHT PARAMETERS. PROVIDE LOGICAL IMPLEMENTATION OF AUTOMATION IN THE MSPN. STUDY PROBLEMS ASSOCIATED WITH TELEVISION TRANSMISSIONS TO AND FROM FUTURE MANNED MISSIONS. DETERMINE BEST METHODS OF PROVIDING NOMINAL AND REAL-TIME ACQUISITION DATA TO THE VARIOUS TRACKING SENSORS OF THE MSPN. PROVE STADAN AUTOMATION FEASIBILITY AND PERFORM COST EFFECTIVENESS ANALYSES TO EVALUATE ALTERNATIVE PROCEDURES AND EQUIPMENT.

RTOP NO. 150-22-52 TITLE: INTEGRATED SYSTEMS, ANALYSIS, DEVELOPMENT  
AND TEST (DSN)

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: VICTOR, W. TEL. 213-354-4502

TECHNICAL SUMMARY

THE OBJECTIVES OF THIS TASK AREA ARE TO DEVISE AND DEMONSTRATE INTEGRATED TRACKING AND DATA ACQUISITION SYSTEMS FOR THE DSN MARK III. THESE SYSTEMS INCLUDE TELEMETRY AND COMMAND SYSTEMS OPERATING AT HIGHER AND MORE VARIABLE RATES IN BOTH THE CODED AND UNCODED MODES; RANGING SYSTEMS OPERATING AT EXTREMELY LOW SIGNAL-TO-NOISE RATIOS WHICH NEVERTHELESS PERMIT RAPID ACQUISITION; TRACKING SYSTEMS OPERATING AT BOTH S AND X-BAND SIMULTANEOUSLY SO AS TO CALIBRATE THE EFFECTS OF THE INTERVENING MEDIUM AND PERMIT THE MORE PRECISE NAVIGATION REQUIRED ON GRAND TOUR MISSIONS TO THE OUTER PLANETS: TRACKING STATION AND SPOF AUTOMATION, CONTROL, AND SIMULATION SYSTEMS TO PERMIT MORE RELIABLE AND MULTIPLE-MISSION OPERATION, TO REDUCE NETWORK OPERATING COSTS, AND TO REDUCE TURNAROUND TIME BETWEEN DIFFERENT MISSIONS: AND RELIABILITY-MONITORING SYSTEMS TO PERMIT THE RAPID DETECTION AND REPLACEMENT OF WORN-OUT AND UNRELIABLE PARTS AND SUBSYSTEMS IN THE DSN. DEEP SPACE STATION DEVELOPMENT IS ACCOMPLISHED IN THIS TASK AREA AND DEMONSTRATIONS OF ADVANCED CAPABILITY ARE PERFORMED WHERE POSSIBLE AT THE VENUS TEST BED OF THE DSIF.

RTOP NO. 150-22-53 TITLE: ANTENNA SUBSYSTEMS (DSN)

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: STEVENS, R. TEL. 213-354-4260

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK AREA IS TO IMPROVE THE PERFORMANCE OF THE GROUND ANTENNAS IN THE DSIF SO AS TO INCREASE EFFECTIVE RECEIVED SIGNAL-TO-NOISE RATIO AND TRANSMITTED POWER, PERMIT RECEPTION AT HIGHER FREQUENCIES, AND REDUCE TURNAROUND TIME BETWEEN DIFFERENT MISSIONS USING THE SAME ANTENNA. IN PARTICULAR, THE COST-EFFECTIVE POSSIBILITIES OF LARGER APERTURE ANTENNAS FOR DATA ACQUISITION ARE DETERMINED, USING MEASUREMENTS ON ALREADY-EXISTING ANTENNAS. WHERE POSSIBLE, THE CAPABILITIES OF DSIF ANTENNAS IN NEW OPERATIONAL CONFIGURATIONS ARE DEMONSTRATED IN RADIO SCIENCE AND IN-FLIGHT SPACECRAFT EXPERIMENTS AT THE VENUS SITE TEST BED.

RTOP NO. 150-22-54 TITLE: RECEIVING AND TRANSMITTING SUBSYSTEMS  
(DSN)

ORGANIZATION: JET PROPULSION LABORATORY

MONITOR: STEVENS, R. TEL. 213-354-4260

TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK AREA IS THE DEVELOPMENT OF THE RADIO FREQUENCY PORTION OF DSIF TRACKING STATIONS FOR THE MARK III NETWORK TO PERMIT EFFECTIVE OPERATION AT REDUCED SIGNAL LEVELS; AT HIGHER TRANSMITTED POWER LEVELS; WITH MORE STABLE FREQUENCIES; WITH NARROWER RECEIVER BANDWIDTHS; AND WITH HIGHER RELIABILITY. FURTHERMORE, THE GOAL IS TO MAKE RECEIVER AND TRANSMITTER OPERATION AS NEARLY

AUTOMATIC AS ECONOMICALLY FEASIBLE IN ORDER TO INCREASE RELIABILITY, DECREASE OPERATING COSTS, AND REDUCE MISSION CHANGE OVER AND PRE/POST-TRACK CALIBRATION TIME. WHERE POSSIBLE, NEW TRANSMITTING AND RECEIVING SUBSYSTEMS ARE DEMONSTRATED IN RADIO SCIENCE AND IN-FLIGHT SPACECRAFT EXPERIMENTS AT THE VENUS SITE TEST BED.

RTOP NO. 150-22-55 TITLE: DATA HANDLING AND CONTROL SUBSYSTEMS (DSN)  
ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: STEVENS, R. TEL. 213-354-4260  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK AREA IS THE CONCEPTION AND DEMONSTRATION OF METHODS AND DEVICES FOR EFFICIENT AND ERROR-FREE DATA HANDLING AT THE DEEP SPACE STATIONS OF THE MARK III DSIF SO AS TO PROVIDE RELIABLE AND MULTIPLE-MISSION OPERATION OF TELEMETRY, COMMAND, AND TRACKING SUBSYSTEMS. SUCH DATA HANDLING INCLUDES TELEMETRY SYNCHRONIZATION, DETECTION, DECODING, AND RECORDING; COMMAND MODULATION; AND RECEIVED SIGNAL-TO-NOISE CALIBRATION. THESE METHODS AND DEVICES ARE DEMONSTRATED WHERE POSSIBLE IN RADIO SCIENCE AND IN-FLIGHT SPACECRAFT EXPERIMENTS AT THE VENUS SITE TEST BED.

RTOP NO. 150-22-56 TITLE: DATA PROCESSING AND REDUCTION SUBSYSTEMS (DSN)

ORGANIZATION: JET PROPULSION LABORATORY  
MONITOR: LAIRMORE, G. E. TEL. 213-354-5452  
TECHNICAL SUMMARY

THE OBJECTIVE OF THIS TASK AREA IS THE DESIGN AND DEMONSTRATION OF THE TECHNIQUES NECESSARY FOR THE EFFICIENT AND RELIABLE OPERATION OF THE SPOF IN THE MARK III DSN TO PROVIDE MULTIPLE-MISSION HARDWARE AND SOFTWARE THAT PERMIT THE SIMULTANEOUS OPERATION OF MANY MISSIONS AT ONE TIME, EACH HAVING A WIDE VARIETY OF DIFFERENT REQUIREMENTS AND MODES OF OPERATION. INCLUDED ARE TECHNIQUES FOR TELEMETRY, COMMAND, AND TRACKING DATA PROCESSING; AND FOR ORGANIZATION OF SPOF COMPUTERS TO PERMIT AUTOMATIC AND RAPID FAULT ISOLATION AS WELL AS EFFICIENT ACCESS OF FLIGHT PROJECT PERSONNEL TO THE ENGINEERING SCIENTIFIC DATA RECEIVED AT THE SPOF.

RTOP NO. 150-22-97 TITLE: SPACECRAFT SUBSYSTEMS (LAUNCH VEHICLES)  
ORGANIZATION: MARSHALL SPACE FLIGHT CENTER  
MONITOR: JOHNSON, W. G. TEL. 205-563-1115  
TECHNICAL SUMMARY

THE OBJECTIVES OF THE EFFORT IN THIS TASK AREA IS TO IMPROVE AND DEVELOP SPACECRAFT SUBSYSTEMS AND TECHNOLOGY TO PERFORM THE ELECTRONIC FUNCTIONS NECESSARY FOR EFFICIENT AND EFFECTIVE TRACKING AND DATA ACQUISITION, INCLUDING COMMAND AND CONTROL OF LAUNCH VEHICLES TO BE USED FOR FUTURE SPACE PROGRAMS. THIS EFFORT PRIMARILY INCLUDES GENERAL-PURPOSE VEHICLE SUBSYSTEMS USED IN T & DA PROCESSES AFTER SENSOR INFORMATION IS GENERATED AND BEFORE AN R-F SIGNAL IS FED INTO AN ANTENNA. IT COVERS THE DEVELOPMENT OF (1) ONBOARD DATA

MANAGEMENT SYSTEMS; (2) DATA COMPRESSION TECHNOLOGY; (3) DATA ACQUISITION TECHNOLOGY; (4) DATA RECORDING TECHNOLOGY; (5) ELECTRONIC CIRCUITS AND DEVICES; AND (6) DATA TRANSMISSION, RECEPTION, AND RECORDING IMPROVEMENTS.